

**OBESITY PREVENTION AMONG AMERICAN INDIAN ADULTS: IMPACT
EVALUATION OF A MULTI-LEVEL, MULTI-COMPONENT INTERVENTION**

**by
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ABSTRACT

Prevalence of adult overweight and obesity is alarmingly high, disproportionately so in American Indian and Alaska Native (AIAN) populations. Factors contributing to this health disparity in this population are multifaceted, and include several environmental factors, extreme poverty, and the tendency for AIAN to live in remote and economically-deprived areas where access to healthy foods and physical activity opportunities is low but access to inexpensive and unhealthy foods is high. Many public health experts and researchers have explored the prospect of school, food store, or other institutional obesity interventions as a means of increasing healthy food availability and improving food and physical activity (PA) related behaviors. However, none of these interventions have taken a multi-level, multi-component (MLMC) approach, which is essential for exposure and reinforcement of the intervention messages to all segments of the population.

The Obesity Prevention Research and Evaluation of InterVention Effectiveness in NaTive North Americans (OPREVENT) was a multi-level, community-based adult obesity intervention pilot-study (2012-2015) funded by the U.S. Department of Agriculture (USDA). The program took place within food stores, schools, worksites, and media outlets and was designed to intervene at multiple environmental levels to promote healthier food and PA behaviors such as healthy food purchasing, improved dietary intake, and increased PA.

Five AI communities in Michigan and New Mexico were randomized to either immediate intervention (n=3) or delayed intervention (n=2). Food stores, worksites, and schools were recruited from each community and received intervention materials and support from the OPREVENT study team throughout six intervention phases over the course of one year. Materials and support included posters, educational displays, flyers, booklets, giveaways, and interactive sessions such as taste tests and cooking demonstrations. Respondents were randomly selected from each community, and baseline and follow-up interviews were conducted to assess changes

in food and PA related behaviors, dietary intake, PA level, and psychosocial variables (PSV) as well as to evaluate level of exposure to the intervention. Data for this analysis were taken from the qualitative food frequency questionnaire, the International Physical Activity Questionnaire-Short Form, select sections of the Adult Impact Questionnaire, and the Intervention Exposure Evaluation. Baseline interviews were completed with 424 respondents, and follow-up interviews were completed with 299 respondents.

Results suggest that MLMC interventions such as OPREVENT can be effective in increasing volume of moderate PA (MET-min. per week) and decreasing daily servings of regular soda. No changes were observed in psychosocial variables. Process data (not included in this dissertation) and anecdotal evidence suggest that the dietary and PA materials and messages may have been unclear, and that the intervention was not implemented with high exposure, thereby potentially decreasing the probability of observing significant changes.

These results provide important information related to designing and implementing large MLMC interventions within AIAN communities. First, AIAN adults appear to be more amenable to decreasing unhealthy beverage intake than decreasing unhealthy food intake. There also seems to be potential for increased volume of PA. There was no change observed in any PSV, however there were intermediate to high levels of some PSV (knowledge and self-efficacy) at baseline. Exposure to the intervention was low. Future research should work to identify ways to improve messaging to see changes in additional foods and beverages, and also look into expanding the current MLMC framework to emphasize intervention messages across all environmental levels and community institutions. To increase effectiveness in the future, researchers should ensure that MLMC interventions are implemented with high exposure. Intervention materials should be pilot-tested to ensure that the messages are culturally acceptable, clearly presented, and related to the evaluation instruments.

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CHAPTER 1: INTRODUCTION

1.1 Background

Research has repeatedly shown that American Indian and Alaska Native (AIAN) populations are at disproportionately higher risk of developing chronic disease than any other racial or ethnic group in the U.S. Adult obesity is of particular interest, as the adjusted prevalence has increased more than 25% within the ten-year period of 1995-1996 to 2005-2006. Additionally, obesity is strongly related to the development of several comorbidities including type 2 diabetes and heart disease. There has been longstanding interest in understanding how environmental factors and behaviors, such as nutrition, physical activity (PA), and familial habits within the household influence obesity development and management.

In an effort to address the increasing prevalence of obesity, many trials have been conducted within AIAN populations to design, implement, and evaluate programs that impact modifiable risk factors for obesity and subsequently prevent the development of comorbidities. Few interventions have resulted in significant changes or had lasting impact. Most interventions to date have focused on individual-level behavior change, but have had little impact on obesity prevalence. It has been suggested that multi-level, multi-component (MLMC) community-based interventions are needed.

The Obesity Prevention Research and Evaluation of InterVention Effectiveness in NaTive North Americans (OPREVENT) was a multi-level, community-based adult obesity intervention trial funded by the U.S. Department of Agriculture (USDA) and implemented in five AI communities in Michigan and New Mexico (three communities randomized to intervention, two communities randomized to comparison). There were four components to OPREVENT: 1) community media campaign; 2) school; 3) worksite; 4) and food stores. Study goals included development of a sustainable obesity prevention program, advancement of existing knowledge on

the relationship between behavioral and environmental factors and obesity among AI populations, and the reduction of obesity in AI participants. Primary research questions of the overall intervention included: what is the impact of a multi-site, multi-institutional trial on 1) obesity; 2) psychosocial factors, and food and PA related behaviors; 3) diet and PA; and 4) is exposure to the intervention associated with improvements in obesity status, psychosocial factors, diet and/or physical activity?

The goal of this dissertation was to answer questions two through four regarding the impact of the intervention on dietary intake, physical activity, and psychosocial and behavioral factors, and evaluate whether exposure to the intervention affected impact. The specific aims are:

Aim 1: Determine the impact of OPREVENT on PA.

Hypothesis 1: Adults living in communities randomized to the immediate intervention group will demonstrate significant improvements in PA compared to adults living in communities randomized to the delayed intervention group.

Aim 2: Determine the impact of OPREVENT on dietary intake.

Hypothesis 2: Adults living in communities randomized to the immediate intervention group will demonstrate significant improvements in dietary intake (e.g.: decreased consumption of discouraged foods, increased consumption of promoted foods) compared to adults living in communities randomized to the delayed intervention group.

Aim 3: Determine the impact of OPREVENT on psychosocial factors and food and PA related behaviors.

Hypothesis 3: Adults living in communities randomized to the immediate intervention group will demonstrate significant improvements in psychosocial factors and food and PA related behaviors.

Aim 4: Evaluate the impact of intervention exposure on PA, dietary, and psychosocial factors and food and PA related behavior outcomes.

Hypothesis 4: Adults reporting high exposure to the intervention, either as a whole or to specific components, will demonstrate greater impact than adults reporting low exposure.

The goal of this analysis is to identify effective and practical strategies for the prevention and management of obesity in AI adults in Michigan and New Mexico. Meaningful results can be used to identify feasible and sustainable intervention strategies at multiple ecological levels.

1.2 Summary of dissertation chapters

Chapter 2 provides an in-depth literature review of the topic. The history of obesity and chronic disease in AI populations is discussed, including the overall burden of disease. An overview of the role that nutrition, physical activity, and environmental factors play in weight management is provided, as well as an introduction to MLMC interventions and the potential they have for the reduction and prevention of obesity and related chronic diseases within these populations. A review of previous work leading up to and informing the OPREVENT intervention is also described.

Chapter 3 provides a detailed description of the OPREVENT intervention development and design. The setting is described, and baseline values describing the overall environment are presented. Formative research, the tribal approval process, and the development of OPREVENT components and materials are discussed. A conceptual framework is provided.

Aim 1, to determine the impact of OPREVENT on dietary intake is analyzed in Chapter 4. Aim 2, to determine the impact of OPREVENT on physical activity, is analyzed in Chapter 5. Aim 3, to determine the impact of OPREVENT on psychosocial factors and food and PA related behaviors, is evaluated in Chapter 6. The results of aim 4, to evaluate the impact of intervention exposure on specific outcomes, are incorporated into Chapters 4 – 6. Finally, discussion and conclusions are presented in Chapter 7.

CHAPTER 2: LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

2.1 Literature Review

2.1.1 Obesity and chronic disease in AIAN populations

American Indian and Alaska Native adults (AIAN) are disproportionately affected by overweight and obesity. Estimates from the Center for Disease Control and Prevention (CDC) found that in 2008 – 2010, the percentage of AIAN adults 18 years or older who were overweight or obese was 71.1%, versus 61.9% in non-Hispanic whites^{1,2}. Statistics from the Office of Minority Health also show that AIAN adults are 60% more likely to be obese than non-Hispanic white adults^{3,4}, and data from the National Health Interview Survey show that in 2011 the age-adjusted prevalence of obesity in AIAN adults 18 years or older was 40.8%, versus 27.2% for non-Hispanic white adults⁵⁻⁷. Recently released estimates from the CDC's National Health Interview Survey 2014, just three years later, show no signs of reversing, and may have even increased slightly to 42.3% in AIAN^{8,9}.

There are several risk factors contributing to this increased prevalence of overweight, obesity, and chronic diseases in AIAN, including excess energy intake^{8,10}, high fat intake^{8,11}, low physical activity^{8,12,13}, and genetics¹⁴⁻¹⁷. The Strong Heart Dietary Study Phase II (SHDS), conducted to investigate the intake of dietary nutrients that contribute to cardiovascular disease (CVD) in AIAN populations, reported that AI adults aged 45 or older from Arizona, North and South Dakota, and Oklahoma consumed higher amounts of carbohydrates and sodium compared with NHANES III estimates, conducted at about the same time¹⁸⁻²⁰. Researchers also found that AI women consumed lower amounts of folate, and vitamins A and C, and AI men consumed lower amounts of vitamins A, B6, and E among men¹⁹⁻²¹. Additionally, less than half of participants met the USDA Healthy People 2000 guidelines for reducing risk of chronic disease²²⁻²⁴. Although overall energy intake between the SHDS participants and NHANES III participants was not significantly different, the prevalence of obesity in the AI adults was significantly

higher^{19,20,25}. This confirms estimates from the CDC and suggests that even though energy intakes were similar, diet composition may be playing a part in the increased prevalences of obesity in AI populations. In fact, several studies (including the SHDS referenced above) revealed that AI diets tend to be high in fat^{23,26-28} and rarely meet recommendations for fruit and vegetable intake^{4,29}. The Navajo Health and Nutrition Survey (1991-1992) found that among the Navajo, intake of fruit and vegetables was low (less than once per day) whereas intakes of fats and energy from foods such as fry bread, home-fried potatoes, bacon, sausage, and soft drinks were high and provided 41% of total energy^{6,27}. Major factors identified as affecting food choice were cost, availability, and shelf life^{9,27}.

In addition to dietary risk factors, physical inactivity is more prevalent among AIAN adults as compared to their non-Hispanic white counterparts, with 51.4% of AIAN adults 18 years or older not meeting federal physical activity guidelines compared to 44.1% of non-Hispanic whites^{6,30}. Other studies have also found low physical activity and decreased leisure time activity in AI populations^{15-17,31,32}.

Obesity is linked to the development of numerous comorbidities, many of which disproportionately affect AIAN populations. One such comorbidity is type 2 diabetes. American Indians and Alaska Natives experience the highest prevalence of type 2 diabetes in the United States, and the CDC estimates that they are 2.1 times more likely to be diagnosed than non-Hispanic whites³³⁻³⁵. Prevalence estimates taken from the SHDS were even more disproportionate, at four to five times higher than the national estimates for the general adult population at the time of the study^{19,36-38}. Estimates from the National Health Interview Survey in 2010 found that while the average prevalence of type 2 diabetes in U.S. adults 18 years or older was 7.6%, it was 16.3% in AIAN adults^{34,39-42}. Prevalence of type 2 diabetes in AIAN has been estimated to be as high as 50% in some tribes^{39,43,44}, and CDC data show that estimates can also vary by region, from 5.5% among AN adults to 33.5% among AI adults in the Southwest^{36,45}. Among all U.S. adults, type 2 diabetes is the leading cause of kidney failure, amputation, and new

cases of blindness^{36,46}. American Indian and Alaska Native populations suffer from these diabetes-related complications and comorbidities, in addition to heart disease and depression³⁹⁻⁴². Additional research also identifies AIAN as having increased prevalence of hypertension⁴⁷. Moreover, diabetes-related death rates are higher in AIAN populations, at nearly four times that of the U.S. rate for all other races³⁹.

Heart disease is another obesity-related condition that disproportionately affects AIAN adults, who are twice as likely to be diagnosed as non-Hispanic white adults⁴⁸. The age-adjusted prevalence of heart disease for adults 18 years or older between the years 2004 – 2008 was estimated at 14.7% in AIAN and 12.2% in non-Hispanic whites⁴⁸. American Indian and Alaska Native adults were also more than twice as likely to be diagnosed with coronary artery disease and 1.3 times more likely to have high blood pressure than non-Hispanic white adults³⁴. Finally, AIAN adults 18 years or older are also 2.4 times more likely to suffer a stroke than non-Hispanic whites³⁴.

It has also been suggested that genetics contributes an additional risk factor, known as the “thrifty” genotype. This theory is based on the idea that generations of subsistence living created a thrifty genotype that allowed Native peoples to be efficient in extracting and retaining energy and fat from small amounts of food¹⁴⁻¹⁷. This genetic variation was essential to survival, as it would allow Native peoples to survive during periods of food shortage or uncertainty while also allowing them to maintain energy stores to support their highly physically active lifestyles^{14,49}. However, Native peoples have undergone a rapid nutrition and physical activity transition from a subsistence lifestyle to one of highly processed, energy-dense foods and increased inactivity^{48,50}. Now, Native populations with this genotype experience incredibly high prevalence of obesity and type 2 diabetes. Lee and colleagues^{10,48} provided support for this relationship in their study of type 2 diabetes incidence among AI populations in Arizona, Oklahoma, and the Dakotas (part of the Strong Heart Study^{34,51}) when they found that individuals with a higher degree of Indian blood had significantly higher risk of becoming diabetic^{10,34}. Researchers have also identified significant

additive gene-by-diabetes interaction for weight and BMI within AI populations in the Strong Heart Study^{1,6}. The most dramatic case study supporting this thrifty genotype hypothesis is that of the Pima Indians of Arizona, who have the highest reported prevalence of type 2 diabetes of any group of adults in the world^{3,35}. Among the Pima, 55% of adults older than 35 years of age have type 2 diabetes, with an increasing number of diagnoses occurring in those younger than 30 years of age^{7,19,37,38}. The degree to which a rapid nutrition transition impacted health is most dramatic when the Pima Indians of Arizona were compared to a closely related population of Pima Indians living in the remote and mountainous village of Maycoba in Mexico. Maycoba Pima Indians weighed on average 50 lbs. less than their Arizonian counterparts^{8,34}. In addition, type 2 diabetes was diagnosed in only 10% of the Maycoba Pima Indians as compared to almost 50% in the Arizona Pimas^{8,39,44}. Further analysis showed that the Maycoba Pimas consumed a low fat diet of about 13% protein, 23% fat, and 63% carbohydrates with less than 1% alcohol and more than 50g of fiber per day; additionally, they were engaged in more than 40 hours of strenuous physical activity per week^{8,36}.

2.1.2 Burden of disease in the general U.S. and AIAN populations

Obesity is associated with multiple comorbidities in adults, and the disease and its complications account for a significant portion of medical expenditures. A study by Finkelstein et al⁵² found that in 2006, obese individuals had per capita medical spending that was 42% greater than spending for normal weight individuals. In the same year, the per capita percentage increase in obesity-attributable medical expenditures was 36% for Medicare (primarily driven by non-inpatient services and pharmaceuticals), 47% for Medicaid (primarily driven by pharmaceuticals), and 58% for private payers (driven by inpatient, non-inpatient, and pharmaceuticals)⁵². These costs represent 8.5% of Medicare, 11.8% of Medicaid, and 12.9% of private payer total payments⁵². The authors emphasized the importance of their findings by highlighting the fact that

obesity-attributable costs are almost entirely due to treatment of the diseases that obesity promotes, suggesting that the prevention of obesity should be a top priority⁵².

In 2012, Cawley et al⁵³ used 2000-2005 Medical Expenditure Panel Survey (MEPS) data to estimate the medical care costs of obesity, revealing several staggering statistics. Analysis showed that weighing one additional BMI unit raised annual medical expenditures by \$149 in the pooled sample (\$80 for men and \$173 for women), while being obese (as compared to non-obese) raised annual medical expenditures by \$2,741 for the pooled sample (\$1,152 for men and \$3,613 for women)⁵³. Further, obesity related medical costs were higher for the uninsured than for individuals with private insurance, at \$3,152 and \$2,568 respectively⁵³. Results also showed that obesity raised annual third-party medical expenditures by \$2,418 in the pooled sample, accounting for 88% of effect of obesity on total medical costs⁵³. Costs were then broken down by category, showing increased medical expenditures for inpatient care (\$1,116), outpatient services (\$860), and prescription drugs (\$919)⁵³. Considering per capita costs, obesity at least doubled medical expenditures in most subgroups analyzed, raising costs by 150% in the pooled sample (\$1,763 to \$4,458), 180% in women (\$1,928 to \$5,363) and 540% in the uninsured (\$512 to \$3,271)⁵³. By these estimates, Cawley et al⁵³ determined that the annual direct medical cost of obesity was about \$26 billion over the six-year period, with \$23.2 billion borne by third party payers. Extrapolating this for the full non-institutionalized adult population over aged 18 years, total medical costs in 2005 were estimated to be \$192.2 billion, accounting for 20.6% of U.S. national health expenditures⁵³. Additional data presented by Finkelstein et al⁵⁴ suggested that the prevalence of obesity will increase by 33% over the next two decades to 42% in the year 2030, with 11% being morbidly obese. Researchers also found that a decrease in prevalence of only 1 percentage point would reduce obesity-related medical expenditures by \$84.9 (\pm \$9.3) billion⁵⁴. Additionally, if obesity prevalence had remained constant at 15% as per recommendations of Healthy People 2010, obesity-related medical savings would have equaled \$1.9 trillion⁵⁴.

In addition to medical expenditures, obesity also results in loss of productivity and other indirect costs such as absenteeism and lost productive capacity due to early mortality. Data have shown that across all occupations, the overweight were 32% more likely, the obese 61% more likely, and the morbidly obese 118% more likely to miss work than individuals of healthy weight status⁵⁵. This absenteeism was associated with a cost of \$4.3 billion in 2004⁵⁵.

Obesity is associated with the development of several comorbidities in AIAN populations, the most critical of which is arguably type 2 diabetes. The estimated national cost of diabetes in the U.S. in 2007 exceeded \$174 billion⁵⁶. This estimate includes \$116 billion in excess medical expenditures and \$58 billion in reduced national productivity, as well as indirect costs such as absenteeism, reduced productivity, and lost productive capacity due to early mortality⁵⁶. Individuals with type 2 diabetes have average medical expenditures that are 2.3 times higher than those without type 2 diabetes⁵⁶, and data has also suggested that those with type 2 diabetes use a much higher proportion of medical services and sustain much higher expenses than those without type 2 diabetes who use medical services for other reasons⁵⁷. It is estimated that \$1 in every \$10 health care dollars is attributed to diabetes⁵⁶.

The financial burden of both obesity and type 2 diabetes is even greater within AIAN populations. All AIAN individuals are entitled to health care via the Indian Health Service (IHS 2013) and tribal-contract health care facilities, which are funded by the U.S. Congress⁵⁸. Currently, annual funds can only cover about 60% of health care needs of eligible AIAN people, and therefore the IHS cannot guarantee available funds; services must be prioritized⁵⁸. Unfortunately, in a population that suffers from high health disparities, obesity and type 2 diabetes may not be given high priority. Many AIAN also obtain private insurance to make up for the coverage gap, but about 27% still lack insurance, compared to 14.5% of non-Hispanic whites⁵⁹. Therefore, increased obesity and type 2 diabetes in this population puts even more strain on the already tight budget.

2.1.3 Role of Nutrition in Obesity

It is known that diet and nutrient intake influence the development of obesity. The American Academy of Nutrition and Dietetics (AAND, formerly the American Dietetic Association, ADA), released a position statement on weight management in 2009. The paper emphasized the role of negative energy balance as the most important factor influencing weight loss amount and rate⁶⁰. Authors suggested that energy intake be decreased by 500 – 1,000 kcal/day to achieve a healthy and realistic weight loss of 1 – 2 lbs. per week⁶⁰⁻⁶². A low-fat, reduced-energy diet was also recommended, as it is the most widely studied and frequently recommended diet^{63,64}; however low-carbohydrate diets might also be used in certain circumstances⁶⁰. Recent studies have shown that after six months of dietary intervention, low-carbohydrate diets were associated with greater improvements in triglyceride and HDL cholesterol concentrations than were low-fat diets, but that LDL cholesterol was significantly higher in participants on the low-carbohydrate diets⁶⁵. It was also recommended that 3 – 4 servings of low-fat dairy be incorporated into a weight management program, as low calcium intake (below the recommended level) is associated with increased body weight^{60,61}. Portion control, regular meal patterns (in particular not skipping breakfast), and meal replacements were also discussed as useful tools in weight management, however it is stated that more research is needed^{60,61}.

The Dietary Guidelines for Americans 2010 recommend maintenance of an appropriate energy level by following the Acceptable Macronutrient Distribution Range (AMDR) and utilizing food label information to make informed dietary choices⁶⁴. As with the AAND recommendations, reduced portion sizes and inclusion of breakfast were also encouraged⁶⁴. The recently released Dietary Guidelines for Americans 2015 encourage meeting the AMDR through healthy eating patterns consisting of a variety of vegetables, fruits, whole grains, fat-free/low-fat dairy, a variety of protein foods, and oils, all in proper portion size to assist with weight management⁶⁶.

2.1.4 Role of Physical Activity in Obesity

The role of physical activity (PA) in the prevention of obesity is also well documented. Increasing PA in the absence of additional behavioral intervention is associated with small reductions in body weight, as the American College of Sports Medicine (ACSM) reports that most studies using PA as the only intervention among sedentary or obese individuals do not result in >3% weight decrease from baseline¹³. However, the benefit of PA in weight management is more fully realized when considered additively with dietary modifications to decrease energy intake^{13,67,68}. It also appears that PA plays a more prominent role in long-term maintenance of weight loss and prevention of weight regain^{12,68}.

The Physical Activity Guidelines for Americans 2008 (PAG) and the Dietary Guidelines for Americans 2010 (DGA) recommended that adults should engage in at least 150 minutes of moderate-intensity aerobic activity (30 minutes, five days per week) or 75 minutes of vigorous-intensity aerobic activity (25 minutes, three days per week) each week, which should be performed in increments of no less than ten minutes at a time and spread throughout the week^{64,67}. However, this is only for weight maintenance. Adults attempting to reduce body weight may need at least 300 minutes of moderate-intensity or 150 minutes of vigorous intensity aerobic activity each week^{64,67}. This is supported by the ACSM recommendation of 200 – 300 minutes per week of moderate-intensity physical activity¹³. It is also recommended that adults engage in muscle-strengthening activities that utilize all muscle groups on at least two nonconsecutive days per week^{64,67} to increase muscle mass, but that it must be done in addition to aerobic training to increase loss of fat mass¹³.

There is also research in children, and results suggest that children and adolescents should engage in at least 60 minutes of PA per day⁶⁹. Based on this, PA guidelines for children and adolescents have been established by a number of different organizations. The CDC and the World Health Organization (WHO) recommend that children aged 5 – 17 years old accumulate at

least 60 minutes of moderate- to vigorous-intensity PA daily, with the majority of the 60 minutes being aerobic^{70,71}. The PAG and DGA also recommend at least 60 minutes or more of PA daily^{64,67}. It is also recommended that vigorous-intensity and muscle and bone strengthening exercises be included on at least three days per week^{70,71}. However, it is recognized that more research is needed.

The ACSM also recommends lifestyle PA, such as walking done for commuting or on the job site, as a component in weight management efforts¹³. Research has investigated the use of pedometers in tracking and increasing lifestyle physical activity. Goals of 10,000 steps per day are typically promoted for adults using pedometers, which is consistent with the 30 minutes, five days per week recommendation set forth by the DGA^{19,68,72}. A meta-analysis found that pedometer users increased PA by 29.6% over baseline, and that setting the 10,000 steps per day goal was a predictor of increased PA⁷³.

Promotion of PA is also approached via discouraging physically inactive pastimes. Research suggests that children and adolescents should limit daily screen time to less than 60 minutes per day⁶⁹. The DGA recommended limiting screen time to 1 – 2 hours per day, especially in children and adolescents^{64,67}. Reducing screen time can lead to more time spent being physically active and also reduce the possibility of mindless eating while watching television^{64,67}.

2.1.5 Physical and Social Environmental Influence on Obesity

Physical and social environmental factors are also associated with higher energy and fat intake⁷⁴⁻⁷⁹ and lower energy expenditure^{80,81}. Socio-economic status (SES) and its impact on the environment play a critical role in influencing obesity in this population. American Indians have the highest poverty prevalence of any race or ethnicity in the U.S. at 27%⁸². In nine states the poverty prevalence in AI is even greater, at over 30%⁸². Low SES and poverty in AI in particular is associated with unemployment, poor quality diet, physical inactivity, overcrowded or poor living conditions, psychosocial stress, and chronic illness⁸³. It can also affect the food

environment, which has been found to be a particularly important factor affecting food access and influencing choice in AI communities^{84,85}. Many AIAN communities only have access to small food stores with limited selection of healthy food options, poor quality fruits and vegetables, and high variation in prices⁸⁶. The typically rural locations of AI communities lead food stores within these communities to stock non-perishable often highly processed, high fat, high energy foods²⁷. Improved access to and availability of healthy foods are influenced by type of food store and selection available at the stores⁸⁷, and previous work has demonstrated that changing the food environment in AI communities may be a viable way in which to positively influence dietary quality while working towards the overall goal of reduction of obesity^{84,88}.

In addition to SES and the food environment, the built environment, including land use patterns and transportation systems, can also have a major impact on health, and particularly physical activity levels⁸¹. The home environment is also influential, and preparing and eating meals together as a family has been shown to positively influence eating patterns, especially for adolescents⁸⁹. Cultural perceptions and norms on body image can influence the degree to which obesity is considered a salient health concern. Adult AI report a preference for larger body size as compared to Anglo populations^{22,24}.

2.1.6 Potential of Food Store Programs for Obesity Intervention

Past research has explored the efficacy of food store, school, and work site programs for the prevention of obesity. Food stores, such as supermarkets and small convenience stores, are promising venues for dissemination of health information and encouragement of healthy food purchases. The existing evidence on such programs is taken from studies conducted in larger cities which show positive impacts on purchasing of healthy foods and increased knowledge⁹⁰. Some studies have found that the presence of supermarkets and grocery stores is positively associated with improved diet, increased fruit and vegetable consumption, and decreased rates of chronic disease, including obesity⁹¹⁻⁹³. Others studies have found no effect on dietary habits or

obesity yet some effect on various psychosocial indicators⁹⁴, and environmental studies are promising yet inconclusive⁹⁵. Despite lack of conclusive evidence, there have been several food store-based interventions conducted in AI populations similar to that used for OPREVENT that have shown that food store programs can be associated with positive changes in both dietary habits and weight status⁹⁶⁻⁹⁹. The only such analyses done on food store programs in AIAN and Canadian First Nations (FN) communities have been done by Gittelsohn and colleagues^{96,100,101}. Additionally, there have been few evaluations of food store programs in conjunction with other institutions, such as schools (one exception being Zhiwaapenewin Akino'maagewin, detailed in **Table 2.1**).

2.1.7 Children as Change Agents

Several studies have examined the role that children play in initiating behavior change in adults. For example, children are able to act as change agents by requesting healthy food purchases at the grocery store or asking an adult family member to engage in a physical activity with them. Studies have shown that children can be especially effective as change agents when it comes to impacting family diets, in particular fat intake¹⁰². Other studies have used children as change agents within the home to modify dietary and other health behaviors of adults¹⁰³⁻¹⁰⁵. There is also evidence that a school-based program for children can result in decreased fat consumption in their family members as well as healthier grocery store purchasing habits^{106,107}. Finally, elementary school aged students as change agents led to increased fruit and vegetable availability and consumption and a decrease in adult BMI¹⁰⁸.

2.1.8 Potential for Small Behavior Change

The recommended goals of weight management set forth in the AAND position paper on weight management had an overall focus on behavior change. Goals for weight management

included prevention of weight gain or stopping weight gain in at-risk individuals and developing healthful lifestyle behaviors with an emphasis on behavior modification, all while maintaining realistic expectations of ideal weight and time required to achieve change⁶⁰. These recommendations reinforce the idea that small incremental behavior changes can have great potential in weight management.

2.1.9 Obesity Prevention Interventions in American Indians

Table 2.1 summarizes several obesity prevention intervention studies in AIAN populations (studies for which Dr. Joel Gittelsohn was the PI or Co-PI are denoted by an *). The studies presented in **Table 2.1** were similar in the overall objective to prevent obesity in AIAN adolescents and adults, but differed in design, methods, setting, and ultimately, results. Of the school-based programs (¹⁰⁹⁻¹¹³) several resulted in improvements in psychosocial factors such as self-efficacy, intentions, and knowledge. There were also improvements in dietary intake such as increased fruit and vegetable intake and decreased percent fat intake. The food store-based programs ⁹⁶⁻⁹⁹ also found positive outcomes, including increased purchasing of healthy foods and improved dietary intake. However, these interventions operated at selected levels and institutions within the communities, and did not utilize a comprehensive multi-level, multi-institutional approach to influence the overall environment. The OPREVENT program was developed to address these gaps.

The Pathways Obesity Prevention Program was a school-centered, randomized, 3-year trial of obesity prevention in AI children, with an overall goal to reduce obesity and a secondary goal to significantly decrease the percentage of energy consumed as fat by children in the intervention group ¹¹⁴. Researchers reported significantly smaller mean intakes of total fat and saturated fat as percentages of calories compared with controls¹¹⁴, supporting the basis of decreased energy intake from fat as a primary outcome in OPREVENT. Physical activity data from Pathways, while exhibiting a trend for increased physical activity in the intervention schools

for three of the four study sites, and an overall difference of ~10% between intervention and control schools, did not result in significant increases in PA¹¹⁵. Despite varied results, Pathways was a key study in the potential of school- and family-based interventions for the primary prevention of obesity in AI communities.

The Kahnawake Schools Diabetes Prevention Project was a 3-year elementary school-based project that took place among AI children in the Kahnawake school district located in the Canadian Province of Quebec. The goal of the program was to decrease future occurrence of type 2 diabetes, prevalence of obesity, high calorie and high-fat diets, and physical inactivity among elementary school children ages 6 – 12 years¹¹⁰. Researchers aimed to increase the proportion of children consuming a balanced diet and participating in physical activity¹¹⁰. Outcome measures included fitness levels, body composition, behavioral assessments of eating habits, and physical activity patterns¹¹⁰. Results at two years revealed that skin-fold measurements were increasing less rapidly in the intervention compared to the control community, however this trend was not maintained through the eight-year follow-up period¹¹⁰. Favorable changes to dietary behaviors such as decreased consumption of key high-fat, high-sugar foods (colas and whole milk) were coupled with less healthy habits of decreased fruit and vegetable consumption¹¹¹. Additionally, this sub-analysis did not include a control group, giving the results low normative value¹¹¹. However, the main objective of decreased obesity was not met.

Another program was the Sandy Lake school-based diabetes prevention program implemented by Saksvig and colleagues (2005). This program was designed to demonstrate that after one year, a culturally appropriate school-based intervention would increase students' knowledge, skills, and self-efficacy while positively changing behaviors related to diet and physical activity¹¹³. Positive results showed that increased exposure to the intervention was significantly associated with meeting the age + 5 g/d dietary fiber recommendation, percent energy from dietary fat was significantly decreased, and exposure to the intervention was significantly associated with children being more active, more knowledgeable about foods low in

fat, and having higher dietary self-efficacy¹¹³. However, mean BMI and percent body fat actually increased during the intervention period (perhaps due to a short, 1-year intervention period), and there was no control group¹¹³. Despite this, the Sandy Lake program provided a good example of a culturally appropriate and sustainable school-based obesity intervention.

The Zuni Diabetes Prevention Project was a five-year high school-based diabetes prevention program among adolescents of the Zuni Pueblo of New Mexico. Objectives were to change the behaviors associated with risk of type 2 diabetes, including food intake, physical activity, and knowledge¹¹⁶. The goal was the prevention of deterioration of plasma insulin and glucose measures over the four years of high school¹¹⁶. The intervention was successful in decreasing soft drink consumption, and results also showed a significant decrease in 30-min insulin levels and a downward trend in 30-min glucose levels¹¹⁶. Although this study was among the first to show success in targeting the environment and education for change at the community level, no impact on BMI was observed¹¹⁶.

Zhiwaapenewin Akino'maagewin (ZATDP) was a multilevel, multi-institutional program to improve diet and increase physical activity in seven First Nations in Canada, and consisted of school, food store, and community level intervention components. The school component was modeled after Pathways whereas the food store component was similar to Apache Healthy Stores (AHS, detailed below)⁸⁴. Results revealed a greater improvement in healthy food acquisition scores and knowledge scores among intervention respondents¹¹⁷. There were no changes observed in physical activity behaviors¹¹⁷. The ZATDP program was primarily undertaken as a feasibility study, and was successful in demonstrating several implications for future program development.

Healthy Foods North (HFN) was a one year long pilot intervention in Inuit and Inuvialuit First Nations populations designed to reduce risk of chronic disease through improved diet and increased physical activity¹¹⁸. The program was multi-level and multi-institutional, and focused on the promotion of healthier food preparation methods, traditional foods, and increased availability of healthy foods in stores¹¹⁸. An evaluation of the program found that participants

reduced both the consumption of de-promoted foods and the utilization of unhealthy cooking methods (such as pan-frying with added fat), resulting in a significant increase in the use of healthy food preparation methods over the 12 months¹¹⁸. Additionally, the intervention group showed greater reduction in consumption of de-promoted high-fat meats, high-fat dairy, refined grains, and unhealthy drinks, as well as decreased overall energy intake, and improved vitamin A and D intake¹¹⁸.

Apache Healthy Stores (AHS) was an environmental, community-based intervention with the objective of increasing the availability of healthy food items in local food stores and also increasing purchase and consumption of these foods⁹⁹. Baseline results showed that higher-fat, higher-sugar, and pre-prepared foods were frequently purchased¹¹⁹ but after the year-long intervention there was evidence of increased purchase and consumption of healthier foods¹¹⁹. Analysis revealed that the program was successful in increasing food-related knowledge, healthy food intentions, and frequency of healthy food acquisition⁹⁹. There were also small improvements in increased intake of promoted healthy foods (vegetables, high-fiber cereals, and low-fat milk) and decreased intake of high-fat, high-sugar foods related to degree of exposure to the intervention⁹⁹. However, improvements in health outcomes were not assessed, and a process evaluation revealed that while the food store level and individual components were implemented with high fidelity, the media component (posters, newspaper cartoons, and radio broadcasts) was not¹⁰¹. Despite this, AHS was essential in demonstrating the potential for food store-based interventions and showing that they can influence food-related behaviors. It was also important in establishing that the preparation and consumption of high-fat foods in AIAN populations is common, and may contribute to the high prevalence of obesity.

Finally, Navajo Healthy Stores (NHS) was implemented in collaboration with the Navajo Special Diabetes Project (NSDP) with the overall goal to improve dietary patterns amongst Navajo and to reduce risk of obesity by increasing the availability, purchase, and consumption of healthy foods⁹⁶. Researchers found an impact of the intervention on shelf label-driven healthy

food purchasing, improved psychosocial and behavioral factors by degree of exposure (higher exposure lead to increased healthy food intention scores, frequency of getting healthy foods, and significant decreases in BMI)⁹⁶. This study was especially notable as it was the first community-based trial to show an impact on weight status among adult AI⁹⁶. The NHS study was particularly important as it demonstrated the potential for food store-based interventions to influence weight status.

Another study similar to OPREVENT incorporated a multi-level implementation design to prevent type 2 diabetes in an indigenous Canadian population. In addition to a nutrition component, the study promoted PA in the form of exercise classes and walking groups. Cross-sectional analysis showed an increased prevalence of sweat-producing activity among intervention participants over the two-year study period, however this effect did not hold after adjustment for multiple comparisons¹²⁰. Authors concluded that the study had failed to activate the community to sufficiently enable individual and collective change, that theory and previous work had not been integrated effectively, and that the study duration was too short to observe changes¹²⁰.

The Native Hawaiian Diabetes Intervention Program employed a family support model to deliver a 6-month lifestyle intervention to promote healthy dietary and PA behaviors¹²¹. Mean changes in PA behaviors as measured by the Modified Activity Questionnaire were not significant from baseline to follow-up¹²¹.

Other studies promoting PA have shown success. A type 2 diabetes intervention in Pima adults randomized participants to either an active group that encouraged increased energy expenditure through PA, or a cultural group that promoted health and wellness through an appreciation for Pima culture. Analysis at 6 and 12 months showed that both groups reported increased PA, primarily through walking¹²².

Obesity prevention studies have also been done in non-AI children of various races and ethnicities, again showing mixed results. Shape Up Somerville aimed to decrease obesity in

elementary school aged children by creating change in multiple environments within the Somerville community, one of which was increasing opportunities for physical activity¹²³. Among children exposed to the intervention, there was a significant increase in participation in organized sports and physical activities and a significant decrease in screen time¹²³.

These data provide evidence that nutrition-based interventions in this population are not only feasible but that they can be successfully implemented and carried out with modest yet positive results. However, despite some positive findings, research has yet to identify an optimal lifestyle intervention to prevent obesity and its related comorbidities in AIAN populations. The studies highlighted above establish the potential for success of community-based, multi-level interventions, but none combined all levels into one study. Taken together, several gaps in the literature can be identified: the need to include worksites and food stores as a part of a multi-level intervention, increase the emphasis on physical activity, use of children as change agents, and the need for a control group. The proposed study was designed to address these gaps, and work towards the development of effective and sustainable obesity prevention strategies for AIAN adults.

Table 2.1: Summary of obesity prevention intervention studies in Native North American populations

Study	Description	Results
*Pathways ¹⁰⁹	School-based obesity prevention program among AI children in 7 tribes	Improved psychosocial factors, reduced % energy from fat; no impact on BMI or physical activity
Kahnawake Schools Diabetes Prevention Project ^{110,111}	School-based diabetes prevention program among AI children in Kahnawake school district	Skin-fold measures increased less rapidly in intervention; decreased cola and whole milk intake, increased fat-free milk (but no control group); no impact on BMI
*Sandy Lake First Nations School Diabetes Prevention (SLSDPP) ¹¹³	School-based obesity risk factor prevention among children in Sandy Lake	Improved self-efficacy, intentions, increased fiber intake, reduced % energy from fat, policy changes
Zuni Diabetes Prevention Project ¹¹²	School-based diabetes prevention program among AI adolescents in Zuni Pueblo	Decreased soft drink consumption; significant decrease in 30-min insulin levels; downward trend in 30-min glucose levels; no impact on BMI
*Zhiwaapenewin Akino'maagewin:Teaching to Prevent Diabetes (ZATPD) ¹¹⁷	Multilevel, multi-institutional program to improve diet and increase physical activity in 7 First Nations	Improved knowledge and healthy food acquisition frequency
Healthy Foods North ^{97,98}	Multilevel, multi-institutional nutritional and physical activity intervention program in First Nations adults in Nunavut and Northwest Territories, Canada	Significantly greater increases in healthy eating self-efficacy and intentions; significant increase in the use of healthy preparation methods; decreased intake of de-promoted, unhealthy foods
*Apache Healthy Stores (AHS) ⁹⁹	Food store program for obesity prevention on two Apache reservations	Increased purchase of healthy foods; increased vegetables, high-fiber cereals, low-fat milk consumption
*Navajo Healthy Stores (NHS) ⁹⁶	Food store program for improvement of dietary patterns and reduced obesity on the Navajo Nation	Improved healthy food purchasing; improved psychosocial factors, behaviors, and weight status

*Studies for which Dr. Joel Gittelsohn was the PI

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CHAPTER 3: THE OPREVENT INTERVENTION

Overview

American Indian (AI) populations experience the highest obesity prevalence of any ethnicity in the United States. Multi-level, multi-component (MLMC) interventions provide promising strategies to improve obesity-related modifiable behaviors. This chapter describes the development and implementation of the OPREVENT study, a group randomized controlled MLMC obesity prevention intervention that aimed to improve dietary intake and physical activity (PA) by increasing knowledge, building self-efficacy, and influencing intentions for improved behavior change at multiple levels.

3.1 Introduction

American Indians and Alaska Natives (AN) suffer from disproportionately high prevalences of several chronic diseases, including obesity¹⁻³. The health disparities suffered by AI populations are due, in part, to the changing physical, social, and economic environments experienced by many AI people. Among the many tragedies induced by decades of colonization and paternalism was the relocation of many AI populations from their traditional homelands to remote reservations^{4,5}. This forced relocation had devastating and long-lasting repercussions for the AI people, including loss of ethnic identity and culture, economic hardship, and increased health disparities. In the context of this work, it had a significant impact on traditional food and PA practices. As AI peoples were removed from their traditional lands, they were cut off from their historical sources of food and sustenance, forced to adapt to new and often less hospitable surroundings. Decreased access to traditional food sources, in combination with the commercialization and industrialization of the food industry, lead to a rapid nutrition transition from nutrient-dense subsistence foods to energy-dense prepared and packaged foods often high in fat and refined carbohydrates, associated with increased prevalence of obesity and other chronic

diseases⁶⁻⁸. A PA transition was quick to follow, as traditional forms of PA such as hunting and gathering were no longer necessary for survival^{6,9,10}.

Today, AI populations suffer from the highest prevalence of poverty of any other race or ethnicity in the U.S.. At the start of the current decade, it was estimated that 27% of all AI lived below the poverty line, and that in nine states the estimate was 30%¹¹⁻¹³. By tribe, the statistics can be even more compelling, for example 43% live below the poverty line in the Navajo Nation^{1,14,15}. High poverty is related to poor quality diet and low physical activity, in addition to an increased burden of both physical and psychological diseases^{4,16}. It is also related to participation in food assistance programs, and in fact 24% of AIAN receive benefits from the Supplemental Nutrition Assistance Program (SNAP), nearly one million participate in Women, Infants, and Children (WIC), and over 68% of AI children are a part of the National School Lunch Program^{6,17-19}. It is also estimated that the Food Distribution Program on Indian Reservations serves 80,000 individuals per month^{3,6,20,21}. Additionally, food access is low, and the United States Department of Agriculture (USDA) Food Desert Locator tool places nearly all AIAN reservations in food deserts, or areas in which community residents do not live in close proximity to affordable and healthy food retailers^{11,13,22,23}. As a result, food insecurity is high, ranging from estimates of 16.3% of AI households without children, to 76.7% of households in the Navajo Nation^{3,14,15}.

In addition to and as a result of this unstable, unhealthy food environment combined with decreased PA, obesity prevalence has risen to 42.3% of adults age 18 and over^{16,24}. Obesity, in turn, is linked to the development of numerous comorbidities, many of which disproportionately affect AIAN populations. American Indians and Alaska Natives experience the highest rates of type 2 diabetes in the U.S., and the CDC estimates that they are 2.1 times more likely to be diagnosed than non-Hispanic whites^{17-19,25}. Prevalence estimates are as high as 50% in some tribes^{3,18,20,21}. Among all U.S. adults, type 2 diabetes is the leading cause of kidney failure,

amputation, and new cases of blindness^{18,22,23}. Diabetes-related death rates are higher in AIAN populations, at nearly four times that of the U.S. rate for all other races^{3,26}.

Research also identifies AIAN as having increased prevalence of hypertension^{24,27} and heart disease^{25,28,29}. American Indian and Alaska Native adults were also more than twice as likely to be diagnosed with coronary artery disease and 1.3 times more likely to have high blood pressure than non-Hispanic white adults^{18,28,29}. Finally, AIAN adults 18 years or older are also 2.4 times more likely to suffer a stroke than non-Hispanic whites^{18,28,29}.

3.2 Background

The Obesity Prevention and Evaluation of InterVention Effectivenss in NaTive North Americans (OPREVENT) was developed in an effort to address some of these health disparities. The overarching goal of the OPREVENT program was to decrease obesity and diet-related chronic diseases in AI adults through changing the food-purchasing environment, improving nutritional intake, and increasing PA. The three primary aims of the intervention were to 1) develop a sustainable obesity prevention program for AI communities based on formative research; 2) assess the impact of the program on dietary quality and PA; and 3) conduct cost-inventory and cost-effectiveness analyses. The first two aims will be discussed here.

3.3 Theoretical Framework

The conceptual framework that described the OPREVENT intervention and evaluation in the original project proposal is shown in **Figure 3.1**. Based on both Social Cognitive Theory (SCT) and the Social Ecological Model (SEM), this framework outlined the constructs and relationships at each level of the multi-level design, and showed how several of the intervention factors reinforced each other and impacted key mediators of diet and PA. The community level considered food and PA resources as well as media factors as part of the broader physical and

social environment that impacted the three institutions targeted by OPREVENT: food stores, worksites, and schools. Household food purchasers would be exposed to the food store program, working adults would be exposed to the worksite program, and children would be exposed to the school program and share health information with adult members of their households. The multiple intervention sites would reinforce each other and build social support for positive lifestyle change within households. These lifestyle changes would occur at the individual level via key psychosocial mediators, leading to changes in diet, PA, and ultimately, obesity.

Together, the components of OPREVENT and the theories on which it was based worked to address the lack of evidence-based, multilevel obesity intervention strategies in AI populations. No previous intervention has targeted as many levels or integrated the various approaches in the same way that OPREVENT did. Analysis of OPREVENT will provide evidence for best diet, PA, and lifestyle changes to address in MLMC interventions.

3.4 Setting

To be eligible for the OPREVENT program, tribal communities were required to have an on-reservation population of at least 500, at least one on-reservation school, at least one on-reservation food store (grocery store, supermarket, or convenience store), and at least one worksite with no less than five tribal member employees. Letters were sent to the administrations of eligible tribal communities within the targeted areas (Upper Midwest/Great Lakes region and Southwest region) explaining the proposed project and providing contact information for further information if interested in participating. Ten AI tribes expressed interest in participating in this program, and ultimately eight were selected. This was later reduced to five communities due to budgetary constraints. The five communities represented four different tribal affiliations. Three of the communities were located in New Mexico, and two were located on the Upper Peninsula of Michigan. All selected communities were rural or semi-rural. **Table 3.1** summarizes the five communities that participated in the program. Population and demographic data are not always

publicly available for tribal communities, therefore when these specific estimates were unavailable, county data were used.

Community A was the smallest of the five communities with an on-reservation population of approximately 400 residents. The community was located on the Upper Peninsula of Michigan, close to the Northwest shores of Lake Michigan. English is the primary language spoken, although some Elders are able to speak the local tribal language. Community A had a large casino, a convenience store/gas station/take-out pizza restaurant, a health center, a senior center, and one tribal school. The community was approximately 17 miles from a larger town to which many tribal members travel for grocery shopping and other services. Several community members engaged in traditional activities such as hunting, berry picking, and ceremonies such as Pow-wows.

Community B was located on the Upper Peninsula of Michigan, along the Southern shores of Lake Superior, and had a population of approximately 3,700 residents. This community had a large casino, a local radio station, a recreational area for camping and fishing, a senior center, a health center, a library, and a community college. There were five food stores serving Community B and neighboring L'Anse, Michigan where tribal members could purchase food and other services. Community members were actively engaged in traditional activities including hunting, berry picking, and Pow-wows.

Community C was the largest of the five communities, with approximately 6,700 residents. It was located five miles north of Española, in North Central New Mexico. There was a large casino, a gas station/convenience store, a tribal school, a wellness center, and a senior center. Because of its proximity to Española, community members had access to five food stores for grocery shopping. English was spoken, but most tribal members also spoke the traditional language. Community members engaged in many traditional activities, such as fishing, ceremonial dances, and their annual feast day.

Community D was located approximately 85 miles Southwest of Albuquerque, New Mexico and had a population just short of 2,000 residents. Community D had a health clinic, a school, a local radio station, a senior center, a recreational facility, and a gas station/convenience store. Many Elders only spoke the local language, but younger generations spoke English as well. Community members were actively engaged in traditional activities including sheep herding, Pow-wows, and jewelry making, and traditional foods were consumed frequently.

Community E had approximately 1,700 residents and was located 40 miles West of Albuquerque, New Mexico. There was a health center, a senior center, a tribal school, and an adult learning center. There was one small convenience store located on the reservation, but many residents drove the 40 miles to Albuquerque for grocery shopping and other services. Most community members spoke the local language as well as English, although there were many Elders who only spoke the local language. Traditional activities such as sheep herding, Pow-wows, and jewelry making were enjoyed by most community members. Traditional foods were commonly consumed.

3.5 Tribal Approvals

Obtaining tribal approvals is one of the most important steps in working with AIAN communities. Tribes represent sovereign nations, and any proposal to conduct research with AIAN peoples or on AIAN land must first be approved by all proper authorities. Letters of support and memoranda of agreement should also be obtained from stakeholders within each community. In doing so, rapport is built and relationships are formed, and the process demonstrates the researcher's intent to respect and work with the tribal community and its members in a mutual partnership. Following these steps adheres to the Belmont Report, and the basic ethical principles of respect for persons, beneficence, and justice, which have been overwhelmingly ignored among these nations throughout history.

The tribal approval process began with speaking to tribal community leaders about interest in participating in the study. Letters of support were obtained from schools, school boards, health agencies, and other such agencies that would be impacted by the proposed intervention. Memoranda of agreement with local schools, food stores, worksites, and health organizations were also obtained. Once obtained, a formal presentation was made to the local authority (Chapter or Tribal Council) and the nutrition problem and proposed intervention were discussed, after which a formal vote for a resolution was approved. The written proposal was then sent to the tribal or Indian Health Service (IHS) Area Office for approval where it was reviewed and returned to investigators with questions and comments. Once all questions and comments were addressed and approval obtained, all information, letters of support, and approvals were sent to the tribal or IHS IRB for approval.

Period updates were provided for tribal groups and health boards. Quarterly and annual reports, an annual continuation request, and six-month and annual reports were submitted to tribal or IHS IRB.

3.6 Program Design and Implementation

3.6.1 Formative work

Formative work, including participant observation, focus groups, workshops, household group interviews, and in-depth interviews with community members and stakeholders, was carried out for several months prior to the intervention development and implementation, beginning in the summer of 2010. The aim of the formative work was to further understand the context of obesity in the study communities, to identify social and environmental factors either contributing to or working against the obesity problem, and to work with community members to identify problem foods and behaviors in each community and develop key intervention messages and materials. Central issues were prioritized and strategies were developed. This process allowed

community members to participate and develop sense of ownership of the intervention program as well as to ensure that all materials and messages were culturally appropriate and acceptable. This information then went into the formulation of the data collection instruments and community specific curriculums.

During community workshops, investigators presented an overview of the status of American Indian health in the U.S. with a focus on obesity and diabetes, using the latest data from U.S. Census and IHS. Key community health issues and concerns were discussed and workshop participants were encouraged to brainstorm to identify 1) salient health issues for the community; 2) prioritized problem foods; 3) prioritized acceptable alternatives to these foods; 4) prioritized unhealthy food behaviors; 5) prioritized alternative behaviors to promote; 6) preferred modes of communication (newsletters, radio, presentations, billboards, meetings, etc.); and 7) development of culturally appropriate healthy messages for the community. All community workshop participants received a \$20 gift card for their time and contributions.

Feedback was also solicited for intervention materials design. It was essential that all materials be culturally appropriate and representative of the participating communities. Local graphic artists were employed to design all graphics for the OPREVENT materials. The OPREVENT logo was designed based on this feedback, and featured a traditional medicine wheel in ceremonial colors of yellow, red, and black, with feathers on either side. These three colors were used throughout all OPREVENT materials for continuity. Characters used in the school curriculum were given names common to the participating tribes, and drawn to be representative of the communities.

The formative phase also resulted in the publication of several manuscripts summarizing the findings. These include a summary of children as change agents for adult food and PA in AI households in the Upper Midwest³⁰ and a qualitative study on women's coping strategies for obesity risk-reducing behaviors in AI households³¹.

3.6.2 Intervention Phases and Promoted Messages

Phases. The intervention was implemented in six phases: 1) Choose Wisely; 2) Make a Plan, Set a Goal; 3) One Step at a Time; 4) Make it Count, Make it Last; 5/6) Live Life in a Good Way/Celebrate the New You. Each phase focused on specific target foods (as identified by the communities via formative research), PA, and associated food-related behaviors such as cooking or meal planning. For example, the Phase 1 theme was “Choose Wisely” and each intervention component focused on related content, such as using shelf-labels in the food stores to guide individuals in choosing low-fat milk instead of whole milk. Intervention messages were culturally and economically acceptable and appropriate.

Promoted Messages. The OPREVENT program promoted behavior changes for modifiable risk factors related to obesity and diet-related chronic diseases. As such, one key behavior change was improving dietary intake. Based on formative research, acceptable alternatives to problem foods were promoted within the communities. These included a combination of fruits, vegetables, whole grain products, low-fat snacks, and low-calorie beverages. Promotional materials such as posters and flyers advertised these foods, while educational displays and booklets provided more detailed information and education. Interventionists also conducted taste tests and cooking demonstrations to promote these foods. **Table 3.2** summarizes the foods promoted within each phase of the intervention. Promoted foods were identified with shelf-labels to make them easier to identify for consumers.

Another key behavior change was increasing PA. Promotional materials provided educational information on types and intensities of PA, and suggestions for success such as setting goals and tracking progress, exercising with friends, and getting the whole family involved. Flyers were also used to promote the worksite Pedometer Challenges (described in section 3.6.3).

3.6.3 Environmental Levels

The OPREVENT program aimed to improve diet and PA habits of participants by integrating several different components at multiple environmental levels that were mutually reinforcing in their goals to increase knowledge, build self-efficacy, and influence intentions for improved behavior all within the overall context of changing the environment and improving the health related choices that individuals could make within their communities. Primary messages focused on modifying specific behavioral risk factors for obesity, including reduced caloric and fat intake, increased consumption of fruits and vegetables, and increased PA. Intervention components used materials and messages that focused on foods, PA, and behaviors that were culturally appropriate to the participating AI communities.

Food Stores. The OPREVENT food store program was adapted from Apache Healthy Stores and Navajo Healthy Stores programs, with the objective that food stores would acquire the skills and knowledge to support healthful behaviors in food selection, preparation, and serving. The food stores were also the primary venue for environmental change. Intervention stores were asked to stock and promote certain healthy foods, while community media activities promoted them. Healthy foods to be stocked and promoted were based on less healthy foods that were already acceptable and available in the intervention food stores, but were of equal or lesser cost than those less healthy alternatives^{26,32}. All owners, managers, and staff of the intervention food stores attended training to implement the changes. The food stores were asked to improve the availability of healthy choices, to promote these choices, and to teach healthy cooking methods, all with the assistance of OPREVENT intervention materials such as shelf labels, taste tests, and cooking demonstrations.

Worksites. The OPREVENT work site program was adapted from Healthy Foods North and aimed to improve nutritional intake in the workplace while also increasing the amount of PA. Local worksites, such as food stores, government offices, and casinos, were recruited for this component. Coffee station makeovers were implemented throughout the intervention, for which

less healthy options, such as whole milk and sugar, were replaced with healthier alternatives, such as skim milk and zero-calorie sweeteners. Physical activity was encouraged via the implementation of pedometer challenges. This approach has been shown to be successful in previous studies^{27,33}. Pedometers were distributed to employees who were interested in participating and weekly monitoring of steps was encouraged. Prizes were awarded to individuals who met certain goals.

Schools. The OPREVENT school program was an adaptation from the Sandy Lake School Diabetes Prevention Project and Zhiwaapenewin Akino'maagewin (ZATDP) school programs, and was developed to integrate with the food store, worksite, and community intervention components. The primary adaptations included making the materials culturally appropriate (by using Southwestern tribes), adding components for the 5th – 6th grades, and including additional components designed to motivate children to act as change agents within their households. The storybooks followed an AI family as the father is diagnosed with type 2 diabetes and the whole family learns about health, wellness, and prevention of risk factors such as obesity. The characters in the family represented each of the tribal affiliations participating in OPREVENT, and were used throughout all promotional materials and intervention levels.

The adapted classroom curriculum was implemented in the 2nd – 6th grades of participating schools. The curriculum was composed of 16 weekly, 45-minute teacher-led units. Each unit began with a story to introduce main themes and concepts and continued with hands-on learning activities and in-class PA breaks. The 5th and 6th grade components were adapted from NutriBeeSM, and focused more on student-initiated activities, such as media awareness.

A major focus of the school curriculum was to motivate children to act as change agents within their households. They were encouraged to share what they learned from the curriculum with their family members, request healthy foods, and encourage family physical activity. The children also set goals for healthy eating and exercise with their adult household members, which were meant to be achieved with the assistance of take-home family action packs. To encourage

children as change agents, strategies such as family-oriented community kitchen activities, informational booths during parent-teacher nights, and newsletters, were employed. Schools were also encouraged to consider policy changes that would ban sugar sweetened beverages and fatty snacks.

Media. The OPREVENT media component was designed to integrate the school, food store, and worksite components while reinforcing the key intervention messages. Newsletters were mailed to intervention community members in Michigan, while radio announcements were used in intervention communities in New Mexico. Messages were delivered by local community members and in the Native language whenever possible.

3.6.4 Training

Interventionist trainings took place in both Michigan and New Mexico prior to program implementation. During each training, intervention activities for each phase were scheduled and discussed in detail. Interventionists practiced each interactive session, such as taste tests and cooking demonstrations, and were trained to deliver intervention messages and answer questions from community members. Team building meetings were held throughout the intervention whenever they were needed, for example: transition to a new phase of the intervention, new staff or leadership at the community level, retraining and refocus, problem solving for new issues, and requests for materials.

3.6.5 Implementation

The intervention was implemented over one year, from May 2012 to May 2013. Process data were collected for each component (food store, worksite, school, and media) and measured intervention dose, reach, and fidelity. These data were not analyzed for this dissertation.

3.7 Evaluation Methods

3.7.1 Study Design

To evaluate the OPREVENT program, a year-long pilot-study was conducted in the five participating AI tribal communities. The OPREVENT program was originally proposed as a community-randomized controlled trial (RCT) for eight tribal communities, assigned to immediate intervention or delayed intervention using a stratified randomization process. Communities were stratified by location, relative isolation, local resources, and language group. Within each stratum, communities were then randomized to either intervention or comparison. After approval, three tribes no longer wished to participate, bringing the number of participating tribes down to five. The remaining five communities were randomized to either Immediate Intervention (n=3) or Delayed Intervention (n=2). Immediate Intervention communities received the OPREVENT program beginning in the summer of 2012, immediately after the conclusion of baseline data collection. Delayed Intervention communities received the OPREVENT program beginning in the fall of 2015, after the conclusion of follow-up data collection. Food stores, worksites, and schools were recruited from each community and in return for volunteering to participate, received intervention materials and support from the JHSPH study team. All community members had the potential to be exposed to the intervention. The study was approved by the JHSPH Institutional Review Board (IRB), the Indian Health Service (IHS) IRB, the Navajo Nation Human Research Review Board (NNHRRB) and the individual participating tribal councils.

3.7.2 Study Hypotheses

The study tested the hypotheses that, by the end of the 1-year intervention, respondents in the three Immediate Intervention communities would 1) have improved dietary intake (as measured by energy intake, percent fat intake, increased fruit and vegetable consumption,

increased fiber intake), 2) improved PA habits (increased days per week engaged in PA, increased time per week engaged in PA, increased physical activity levels, decreased time spent sitting), and 3) improved psychosocial factors and food and PA related behaviors including self-efficacy, knowledge, and intentions as compared to respondents in Delayed Intervention communities.

3.7.3 Eligibility and Recruitment

To be eligible for the evaluation sample, individuals were required to have lived in their current household for at least 30 days, be AI adults aged 18 – 65 years old, be tribal members, and be the main food shopper or preparer in their household. Exclusion criteria included currently pregnant or breastfeeding women. Households within each community were randomly selected from tribal lists, and one eligible adult was randomly selected from each household. If the eligible adult declined to participate, recruitment continued with the next household on the list until the target enrollment was achieved.

3.8 Outcomes and Measures

3.8.1 Dietary Assessment Questionnaire

The Dietary Assessment Questionnaire (DAQ) included a brief Semi-quantitative Food Frequency Questionnaire (QFFQ) and a 24-hr Recall. The DAQ was implemented at baseline and follow-up.

QFFQ. The OPREVENT QFFQ was adapted from QFFQs developed from 24-hr dietary recalls in Canadian First Nations in Northwestern Ontario and the Navajo Nation^{28,29,33}. The questionnaire was brief, at only 45 items, and covered the last 30-day period. Foods promoted and discouraged by the OPREVENT program were included on the QFFQ, and frequency of consumption was reported using eight different categories, ranging from ‘Never’ to ‘Two or three times a day’^{28,29,34}. Amounts consumed were reported using familiar household units (such as

bowls and spoons) or food models representing locally available portion sizes^{28,29,34}. Because the OPREVENT QFFQ was brief, it was not used to estimate total energy or nutrient intakes. Instead, it was used to identify food patterns and intake of the promoted and discouraged foods from the intervention. However, it is possible that the data collected with the QFFQ may provide an approximate representation of total diet because of the limited variety in the diet and available food sources in this setting and population.

24-hr Recall. The 24-hr recall was intended to estimate mean energy and nutrient intake at the population level, and will be used to evaluate the effectiveness of the OPREVENT intervention. Use of 24-hr recalls is recommended for this purpose, and have several positive attributes including: effective capture of short-term diet, interviewer administered, reliance on specific memory (types and amounts), and primarily random measurement error as opposed to systematic. There are, however, a number of considerations to be wary of, including: underreporting of energy among certain populations (women and those with higher BMI), social desirability, and nuisance effects (systematic differences due to day of the week or season). The five step multi-pass method was used, which includes 1) quick list; 2) forgotten foods; 3) time and occasion; 4) detail cycle; and 5) final probe.

3.8.2 Adult Impact Questionnaire

The Adult Impact Questionnaire (AIQ) was modeled after food-related scales developed as a part of the Navajo Healthy Stores study and was used to assess individual behavior and potential mediators and moderators of diet and PA at baseline and follow-up, based on the idea that positively influencing these more distal moderators of diet and PA will lead to improvements in the targeted behaviors of improved dietary intake and increased PA. Scales included: 1) knowledge: respondent's knowledge regarding health behaviors emphasized by OPREVENT; 2) self-efficacy: respondent's confidence to perform various healthy behaviors; 3) intentions: respondent's intentions to perform various healthy behaviors; and 4) outcome expectations:

respondent's perceived benefits of healthy diet and physical activity³². Additionally, the AIQ assessed multiple household level outcomes, including: 1) food purchasing frequency: healthy food purchasing score based on purchases of OPREVENT promoted foods in the last 30-days; 2) food preparation: food preparation methods for commonly consumed foods in last 30-days and overall healthiness of food preparation score; and 3) social support: four dimensions of family and social support for healthy food and PA behaviors.

IPAQ-SF. The AIQ included PA estimates using the modified, short format International Physical Activity Questionnaire (IPAQ-SF). The IPAQ-SF was used to assess days per week, time per week, and MET-minutes per week engaged in all levels of PA as well as PA level (low, moderate, high).

The IPAQ-SF consists of nine items assessing physical activity across four different domains in the last seven days: leisure time PA, domestic and gardening activity, work-related activity, and transport related activity³³. Within each domain, three types of activity are assessed – walking, moderate-intensity, and vigorous intensity – and separate scores are provided for each³³. Activity levels for the IPAQ are measured in metabolic equivalents, or METs. One MET is equal to the rate of energy expenditure at rest, which is measured by the oxygen uptake of 3.5 mL per kilogram body weight per minute³⁴. Moderate-intensity activities are between 3 – 6 METs and noticeably accelerate heart rate and require more work³⁴. Examples include brisk walking, dancing, gardening, traditional hunting and gathering, and carrying/moving heavy loads <20kg. Vigorous-intensity activities are above 6 METs and require large amounts of effort and substantially accelerate heart rate³⁴. Examples include running, aerobics, hiking uphill, shoveling snow, and carrying/moving heavy loads >20kg. Based on formative research, the descriptions and examples of moderate- and vigorous-intensity activity in the IPAQ-SF were modified to be more culturally relevant. An additional question asking whether the level of activity reported in the last seven days was less than average, average, or more than average was also added. Scoring the

IPAQ-SF requires summation of the duration (minutes) and frequency (days) of each type of activity, and domain-specific estimates cannot be determined³³.

Anthropometry and body composition measurements. Body weight was measured twice using a Tanita 300GS (Tanita Corp., Tokyo, Japan) to the nearest 0.1 pound (third time if different by more than 5.0 pounds). Height was measured twice to the nearest 0.5 inch using a stadiometer (third time if different by more than 0.5 inches). Body composition was measured twice via bioelectrical impedance analysis (BIA) using a Tanita 300GS (Tanita Corp., Tokyo, Japan). Waist circumference was measured twice using a retractable measuring tape to the nearest 1mm (third time if different by more than 5 cm). Hip circumference was measured twice using a retractable measuring tape to the nearest 1mm (third time if different by more than 2mm). Measurements were done twice for to allow for averaging of the final accepted value.

Demographic information. Sociodemographic variables were also collected via the AIQ. These included age, sex, household size, marital status, educational level, employment status, current smoking status, personal and family history of chronic disease, and food-assistance program participation.

3.8.3 Intervention Exposure Evaluation

The Intervention Exposure Evaluation (IEE) was used to assess participant exposure to the intervention components. The IEE was administered once at follow-up to all participants in both Immediate Intervention and Delayed Intervention communities. The questions were designed to measure variation in exposure based on participant use of community media, shopping frequency at participating food stores, number of children in the 2nd – 6th grades, employment status, and participation in community events and activities. Respondents were shown intervention materials from each component of the intervention and asked whether or not they recognized and/or acted upon the materials. Red herring questions were included to assess the validity of respondents' answers. Exposure scores were developed using these data.

3.8.4 Process Evaluation

Process data were measured for the duration of the intervention, at least once per phase, from May 2012 to May 2013. Data collectors and interventionists collected this data for each of the intervention components and activities. Food store level data included the Food Store Environmental Checklist and the Food Store Process Form. The former was used to track whether or not the OPREVENT promoted foods were in stock at all participating food stores, and the latter was used to track the presence of OPREVENT promotional materials including posters and shelf-labels. Worksite level data included the Worksite Environmental Checklist, which was used to track available services at participating worksites (vending machines, cafés, physical activity facilities, etc.), the availability of OPREVENT promoted foods in vending machines and other food retailers at worksites, and the presence and quality of items that could help or hinder OPREVENT behavior change messages (walking paths, break rooms with TVs and DVD players that could be used for workout videos, coffee stations stocked with OPREVENT promoted items such as calorie-free sweeteners, water stations, etc.). Media level data included the Mass Media Process Form to track the presence of promotional materials throughout the community and record the number of radio announcements and newsletters delivered for each phase. School level process data were collected using Teacher's Curriculum Checklists for each grade. Teachers reported whether or not each lesson had been taught and provided general feedback and comments. Finally, process data were also collected for each site visit and interactive session using the Interventionist Site Visit Form. Interventionists recorded the reason for each visit, the people with whom they met, and the activities completed. If the visit included an interactive session, they also recorded the number of consumers contacted (reach), the number of items given away, such as recipe cards, taste test samples, or promotional giveaways (dose), and how well each session was delivered (fidelity).

3.8.5 Analyses

Demographic characteristics of Immediate Intervention and Delayed Intervention communities will be compared using means or medians for continuous variables and proportions for categorical variables. Scales will be developed to PA factors, and will be assessed for internal consistency using Cronbach's alpha. Because only five of the original eight communities remained in the program, it is unlikely that randomization occurred. Therefore, the difference in differences (DiD) approach with clustering at the community level will be used to evaluate change in outcomes from baseline to follow-up.

3.9 Discussion

The OPREVENT intervention program was an innovative and partnered approach to the reduction of obesity and other diet-related diseases in five AI communities. The extensive formative phase provided a solid foundation for development of a culturally appropriate program based on the current health attitudes and perceptions within each community, and continued stakeholder involvement throughout the implementation ensured that the intervention was delivered successfully. Involvement of multiple components at several environmental levels resulted in a strong intervention design that served to influence dietary intake, PA, and related factors in a cohesive and reinforcing way.

There is great potential for MLMC interventions in the prevention of obesity and other diet-related chronic diseases disproportionately affecting AIAN populations. To date, research has focused on select environmental levels such as schools only or food stores only instead of taking a MLMC approach. By working within multiple levels, large MLMC interventions such as OPREVENT can address several of the factors contributing to obesity burden within these communities, such as low healthy food access and availability, barriers to PA, and low social support for healthy behavioral changes. Additionally, given that these tribal communities tend to be small and consisting of few food stores, worksites, and schools, these MLMC interventions

can be especially impactful. Entire tribal communities may benefit from such interventions as potential for individuals to be exposed to the intervention increases dramatically.

To our knowledge, only one other intervention has taken such a broad, MLMC approach close to that employed in OPREVENT³⁵. However, this is the first intervention of its kind to address the problem on a large scale and across five communities representing vastly different regions and cultures. The diversity of communities was an added challenge, but one that was addressed through the extensive formative phase to guarantee that intervention messages and materials resonated across all OPREVENT communities.

Results from the evaluation of this program will provide evidence on the effectiveness of large, MLMC adult obesity interventions in AIAN populations. Such interventions may decrease prevalence and burden of diet-related chronic diseases in these communities.

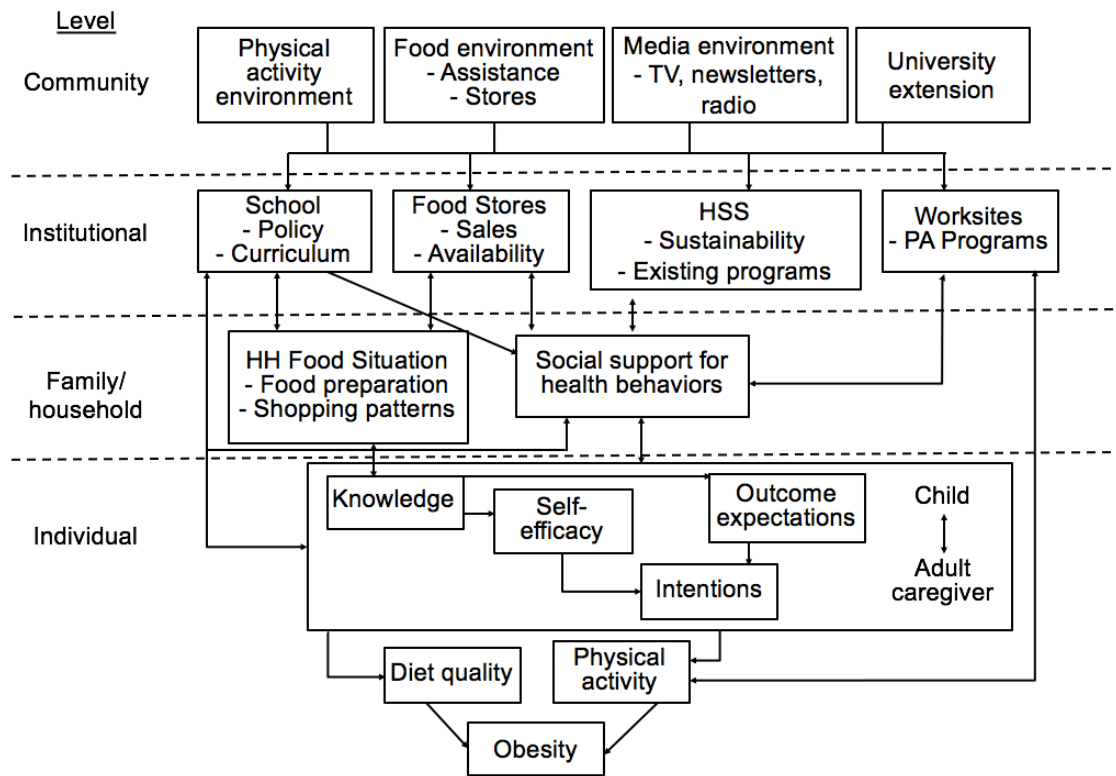


Figure 3.1: OPREVENT Conceptual Framework

Table 3.1: Characteristics of participating tribal communities, 2011-2015

Community (County)	Population ^{a,b}	% AI ^b	Median Household Income ^b	% Below Poverty Line ^b	% High School Education ^b	# Participating Food Stores	# Participating Schools	# Participating Worksites
Community A (Menominee County, MI)	~400 ^a 23,548 ^b	2.9	\$40,373	16.9	90.2	7	1	7
Community B (Baraga County, MI)	~3,700 ^a 8,575 ^b	13.9	\$39,803	17.3	82.4	5	1	5
Community C (Rio Arriba County, NM)	~6,700 ^a 39,465 ^b	18.5	\$36,098	24.2	81.5	5	1	5
Community D (Socorro County, NM)	~1,952 ^a 17,256 ^b	13.7	\$34,037	23.5	76.8	4	1	4
Community E (Bernalillo, Cibola, and Sandoval Counties, NM)	~1,700 ^a 27,329 ^b	42.1	\$34,565	29.2	81.4	4	1	4

^aStatistics given for AI community³⁶

^bStatistics given for county³⁶

Table 3.2: Promoted foods for each intervention phase

Phase	Shelf Label	Promoted foods
1. Choose Wisely	Lower in sugar (<10g sugar per serving)	<ul style="list-style-type: none"> - Water - Diet soda - Reduced-sugar drink mixes
2. Make a Plan, Set a Goal	Lower in fat (<10% daily value fat per serving)	<ul style="list-style-type: none"> - Cooking spray - Low-fat bologna or turkey luncheon meat - 100% whole wheat bread - Fresh fruit - Low-fat and/or fat-free mayonnaise
3. One Step at a Time	Higher in fiber (>10% daily value fiber per serving)	<ul style="list-style-type: none"> - Fresh fruit - Canned fruit in light syrup or 100% fruit juice - Water
4. Make it Count, Make it Last	Lower in sodium (<10% daily value of sodium per serving)	<ul style="list-style-type: none"> - Low-sodium pretzels - Low-sodium crackers - Low-sodium canned vegetables - Dried beans
5/6. Live Life in a Good Way/Celebrate the New You	Healthier choice (healthier snack alternatives)	<ul style="list-style-type: none"> - Granola bars - Sugar-free/low-fat Jell-O pudding - Baked chips - Graham crackers

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CHAPTER 4: IMPACT OF OPREVENT ON PHYSICAL ACTIVITY

4.1 Abstract

Prevalence of obesity is disproportionately high in American Indian (AI) populations. The Obesity Prevention Research and Evaluation of Intervention Effectiveness in Native North Americans (OPREVENT) project was a multi-level, multi-component adult obesity intervention implemented within five AI populations to address this burden. Working within food stores, schools, and worksites, OPREVENT aimed to change the food-purchasing environment, improve nutritional intake, and encourage physical activity (PA) among community members. Physical activity was emphasized at worksites and included pedometer challenges as the primary intervention activity. The International Physical Activity Questionnaire-Short Form (IPAQ-SF) was used to measure PA in the evaluation sample at baseline and follow-up. Difference in differences analysis was used to determine whether individuals evaluated in the immediate intervention communities (Immediate Intervention) (n=3) had improved PA outcomes as compared to individuals evaluated in the delayed intervention (Delayed Intervention) communities (n=2). The PA outcomes measured included: average days per week engaged in each intensity of PA; average time per week engaged in each intensity of PA, including percent time spent sedentary; MET-min. per week engaged in each intensity of PA, and PA level category (low, moderate, or high). No significant intervention effect was found comparing Immediate Intervention to Delayed Intervention. Sub-analyses performed on employed participants only also found no significant associations. However, PA levels shifted substantially from low active to moderately active among Immediate Intervention respondents. Future research should focus on increasing exposure to the intervention and emphasizing PA messages within each component of MLMC interventions.

4.2 Introduction

Obesity in American Indian (AI) adults is a serious public health problem. In 2012, the Center for Disease Control and Prevention (CDC) reported that only 30% of AIAN adults were at a healthy weight^{1,2}. American Indian and Alaska Native adults are 60% more likely to be obese than non-Hispanic whites (NHW), and the age-adjusted prevalence in 2011 of AIAN adults ≥ 18 years was 40.8%, versus 26.2% for NHW¹⁻⁴. Recently released estimates from the CDC's National Health Interview Survey 2014, just three years later, show no signs of reversing, and have even increased slightly to 42.3% in AIAN^{1,5-11}. There are several proximal risk factors for this increased prevalence of overweight and obesity in AIAN, including excess energy intake^{1,7,12-22}, high fat intake^{1-4,16,18,23-25}, and low physical activity (PA)^{1,3-5,7-11,16,25-28}.

Insufficient PA is a major contributing factor to the prevalence of obesity in the United States. In 2012 the CDC reported that 33% of all adults were considered inactive based on the 2008 federal Physical Activity Guidelines (PAG) for aerobic activity^{1,5,7-11,29-31}. When combined with the muscle-strengthening guideline, only 21% of AIAN adults met both guidelines, while nearly half (49%) met neither^{1,7,20,22,32-34}. Physical inactivity is more prevalent among AIAN adults than NHW, with 51.6% of AIAN adults ≥ 18 years not meeting federal PA guidelines compared to 43.3% of NHW^{24,25,33,35,36}. Many other studies report low PA and leisure time activity in AIAN populations. An analysis of the Behavioral Risk Factor Surveillance System data from the years between 1985 – 1988 found that a majority of AI men and women reported sedentary lifestyles^{27,28,37-39}. These findings are supported by work in specific tribes and AI communities that shows low PA and high inactivity in Chippewa and Menominee^{30,31,38,40-49}, Anishinaabe First Nations^{33,34,50-53}, AI adults in Kansas^{5,8-11,33,36,54-59}, and participating tribes in the Strong Heart Study^{38,39,60-65}. Participants in the Strong Heart Family Study were also found to have mean pedometer values well below aggregated reference points, with physical inactivity common within all age groups^{20,22,38,43,46,61,66}.

Programs addressing this disparity in PA levels among AIAN adults have not always been successful^{8,51-53,61,67-72}. There is a lack of focus on adults, with many of the existing trials

focusing on children only^{5,8-11,55,61,67,73-79}. Additionally, many programs address the individual only instead of taking a multi-level, multi-component (MLMC) approach. A MLMC approach can influence PA behaviors at multiple levels (such as food stores, worksites, and schools) within a community. The use of theory is essential within MLMC designs, as theory provides an evidence base as well as explanatory and predictive ability, and guides decision-making related to appropriate measures of effectiveness. A systematic review of type 2 diabetes interventions found that of the nine studies reviewed, all four that were theory-based found significant results^{61,64,67,76,78-85}. Founded on Social Cognitive Theory (SCT) and the Social Ecological Model (SEM), MLMC approaches emphasize intervening at the individual and environmental levels, with the idea that in order for behavior change to be sustainable, the underlying cause must be tackled at multiple levels^{20,22,61,86-90}. This allows for maximum exposure to the intervention, as community members will encounter intervention activities and messages at several levels, helping to reinforce the behavior(s) being promoted^{61,69-71,75,77,81,88,91}. There is a clear lack of such interventions in the PA literature, especially among adult AIAN.

To address the growing burden of obesity in AIAN populations and the lack of comprehensive MLMC solutions, the Obesity Prevention Research and Evaluation of InterVention Effectiveness in NaTive North Americans (OPREVENT) intervention was implemented in five AI communities from 2012-2013. In addition to changing the food-purchasing environment and improving nutritional intake, this MLMC program aimed to increase PA among AI adults via education, promotional activities such as worksite Pedometer Challenges, and partnerships with community organizations to support PA opportunities.

The objective of this analysis is to report on: 1) impact of OPREVENT on the frequency (days per week), duration (time per week), and volume or intensity/time (MET-min. per week) of PA; and 2) whether level of exposure to specific components of the intervention was associated with change in PA behavior in AIAN adults.

4.3. Methods

4.3.1 Design

The OPREVENT study was a pilot obesity intervention trial with food store, worksite, school, and media components implemented in six phases over one year beginning in the summer of 2012. The overall objective of OPREVENT was to reduce obesity in AI adults in the intervention communities. Secondary outcomes included improved dietary quality as measured by increased servings of fruits and vegetables, improved nutrient intake as measured by decreased total energy and fat intake, and increased PA as measured by duration of time spent being physically active or sedentary (sitting). The PA outcomes are analyzed and presented in this report.

Physical activity was particularly emphasized during Phases 3 and 4 of the OPREVENT intervention, titled “One Step at a Time” and “Make it Count, Make it Last” respectively, as well as within the worksite component. Each community had approximately five worksites participating in the intervention. Field interventionists visited each worksite once a week for about an hour to check in. The interventionist implemented a pedometer challenge between all worksites to encourage greater numbers of steps, and employees within each worksite were encouraged to form teams and sign up for the challenge. Each challenge participant was given a free pedometer (NL-800) and a logbook to track number of steps each day, which was then recorded by the interventionist during each week’s site visit. Monthly achievement certificate awards were given to the Most Valuable Participant across all OPREVENT communities, and the teams reporting the most steps each month in each community received a free healthy lunch provided by OPREVENT. At the end of the challenge, the top three walkers from each of the OPREVENT communities received an awards plaque. Intervention materials, including posters, flyers, and educational displays, were displayed prominently throughout each worksite to promote the pedometer challenge and support healthy PA habits. Additional educational content

focused on defining culturally relevant types of PA (traditional dancing, walk around the reservation), describing different intensities of PA (moderate and vigorous), the recommended amount of time to be physically active (150min. per week), and proper nutrition to fuel PA, such as healthy fruit and vegetable snacks and rehydrating with water.

4.3.2 Study Population, Recruitment, and Sampling

Data for this study were collected in five AI communities, representing four different tribes, across Michigan and New Mexico. The three New Mexican communities were approximately 5, 40, and 60 miles from towns with populations over 8,000, while the two Michigan communities were approximately 17 and 70 miles from towns with populations over 8,000. Eligibility criteria for communities included having an on-reservation population of at least 500, an on-reservation school, at least one on-reservation food store (grocery store, supermarket, or convenience store), and at least one worksite with no less than five tribal member employees. Availability of PA facilities varied between the communities, as more rural reservations had only their own tribal-owned and operated fitness centers, while residents on reservations with greater proximity to larger non-tribal communities were able to benefit from commercial fitness centers.

Communities were stratified by location, relative isolation, local resources, and language group, and then randomized to Immediate Intervention or Delayed Intervention groups.

Households in each community were randomly selected from tribal lists. Within each household, one adult between the ages of 18 – 65 years old who had been living in the house for at least the past 30 days was randomly selected. Other inclusion criteria included: tribal member and either the main food shopper or the main food preparer for the household. Exclusion criteria included: currently pregnant or breastfeeding women. If the adult was eligible but declined to participate, enrollment continued with the next household on the list. The aim was to enroll 85 adults randomly selected at baseline from each community, resulting in a total $n = 424$. This resulted in

$\alpha = 0.05$ and power = 80% to detect change in percent time engaged in sedentary activity (sitting). Because the sampling was community based, we did not purposively enroll respondents who we knew worked at participating worksites, shopped at participating food stores, or had children in participating schools.

Baseline data were collected in the spring of 2012 and the intervention was implemented from the summer of 2012 to the summer of 2013. Follow-up data were collected 24 – 27 months later, in the fall of 2013 and spring of 2014. Data collectors were tribal community members trained by Johns Hopkins School of Public Health (JHSPH) and fluent in the Native language whenever possible, and also included JHSPH graduate students. Data collection training consisted of several in-person sessions as well as in-service trainings throughout the project to maintain quality of data. Interviews took place in community buildings as well as private homes, depending on the respondents' preferences. The Navajo Nation Human Research Review Board (NNHRRB), Indian Health Service (IHS) Institutional Review Board (IRB), the JHSPH IRB, and individual participating tribal councils approved the study. Signed consent was obtained from all respondents.

4.3.3 Data Collection Instruments and Measures

The instruments used were adapted from both formative research findings and other studies conducted by Gittelsohn and colleagues in AI settings^{61,67,76,78-80,82,84,85,92-94}. Instruments included the Adult Impact Questionnaire (AIQ) and the Intervention Exposure Evaluation (IEE). The AIQ was completed at both baseline and follow-up, while the IEE was completed only at follow-up. Data for this analysis were obtained from the baseline and follow-up AIQs as well as the IEE.

Adult Impact Questionnaire. The AIQ consisted of multiple sections, including questions related to adult self-efficacy, intentions, health attitudes, social support related to dietary and PA

habits, adult health knowledge, and environmental household factors. The AIQ also incorporated a modified International Physical Activity Questionnaire Short Form (IPAQ-SF)^{81,83,88,95,96}, from which the data for this analysis were obtained. The IPAQ-SF is designed primarily for population surveillance of PA among adults ages 15 – 69 years old^{87,88,96-98}. The IPAQ-SF assesses PA across four domains: leisure time, domestic and yard activities, work-related, and transport-related. The IPAQ-SF specifically asks about walking, moderate-intensity PA, and vigorous-intensity PA within the four domains^{81,88,96}. The IPAQ-SF was determined to be appropriate for use in this study for several reasons: validity studies have been conducted in similar populations^{80,82,84,85,88,94,96}; time burden is low for respondents and the higher analytic and cognitive thinking skills necessary for the IPAQ-Long Form are not required; it was easily modified to be more culturally acceptable for our target population through the addition of culturally relevant activities (e.g. household cleaning, digging, running, shoveling snow, herding sheep) as examples for each intensity of PA.; and it was found to be acceptable after pilot testing within the communities.

The AIQ also included sociodemographic information, including age, sex, household size, marital status, educational level, employment status, current smoking status, personal and family history of chronic disease, and food-assistance program participation. Trained data collectors, many of whom were AI and from the communities in which they were collecting data, administered the questionnaires.

Intervention Exposure Evaluation. The Intervention Exposure Evaluation (IEE) was completed at follow-up only. It consisted of several categories to assess type and amount of exposure to the intervention. Categories included: 1) OPREVENT Logo; 2) Shelf Labels; 3) Taste Tests; 4) Posters and Educational Displays; 5) Flyers and Booklets; 6) Store Visits; 7) Giveaways; 8) OPREVENT Newsletter; 9) Radio Announcements; 10) OPREVENT School Activities; and 11) OPREVENT Worksite Activities. Questions were dichotomous, with respondents responding ‘yes’ or ‘no’ to whether or not they had seen or engaged in a particular

aspect of the intervention. There was an additional third option of ‘Not Applicable: did not recognize any materials,’ but this option was not read aloud to the participant as a valid response and was only used as a last resort after probing attempts had failed.

4.3.4 Data Management

Trained data collectors administered paper versions of the AIQ at baseline (spring 2012) and follow-up (fall 2013/spring 2014). Copies were sent to the project’s Data Manager at JHSPH in Baltimore, Maryland where they were reviewed for completeness before graduate students entered the data into a Microsoft Access database (Microsoft Corporation). Finally, the data were then exported to Stata IC 13.1 software (Stata Corp., Colleges Station, Texas) for analysis.

Outliers were identified using the Tukey Method and removed if they were deemed to be influential. Missing data were dropped from analyses. Imputation was not used, as the small sample size would have increased the likelihood of large error related to the assumptions of imputation.

Data cleaning of the IPAQ-SF was performed in accordance with the Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire- Short and Long Forms issued by the IPAQ Research Committee in November of 2005^{88,96}. Accordingly, all responses to duration provided in hours were converted to minutes. Responses of “missing,” “don’t know,” or “refused” were excluded from analysis. Reports of activity for less than ten minutes duration were re-coded to zero, as evidence suggests that episodes of exercise must be at least ten minutes in duration to achieve health benefits^{88,96-99}. Duration of PA within the three domains (walking, moderate, and vigorous) reported as greater than 180 min.[·]day⁻¹ were truncated to 180 min. to allow a maximum of 21 hours of activity in a week to be reported for each domain^{88,96,100,101}.

4.3.5 Scoring of the IPAQ-SF

Scoring of the IPAQ-SF was also performed in accordance with the Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire- Short and Long Forms^{88,96}. Time spent in moderate and vigorous intensity physical activity and walking were calculated and Physical Activity Energy Expenditure (PAEE) was then calculated by multiplying the time reported in each domain by the net metabolic cost of each activity and reported as the volume of PA MET-min.·week⁻¹.

For PA level categories, respondents were coded as meeting the criteria for ‘moderately active’ if they satisfied the following: 1) three or more days of vigorous-intensity activity of at least 20 minutes per day; OR 2) five or more days of moderate-intensity activity and/or walking at least 30 minutes per day; OR 3) five or more days of any combination of walking, moderate-intensity, or vigorous intensity activities achieving a minimum total PA of at least 600 MET-min.·week⁻¹^{6,88,96,102}. Respondents were coded as meeting criteria for ‘high active’ if they satisfied the following: 1) vigorous-intensity activity on at least three days achieving a minimum total physical activity of at least 1500 MET-min.·week⁻¹; OR 2) seven or more days of any combination of walking, moderate-intensity, or vigorous-intensity activities achieving a minimum total PA of at least 3000 MET-min.·week⁻¹^{88,96,99,102}. Respondents meeting neither the ‘moderately active’ nor the ‘high active’ criteria were coded as ‘low active.’

4.3.6 Scoring of the Exposure Scale

An overall exposure scale was developed from the IEE data using similar protocol as used in previous studies conducted by the PI^{32,100,101}. ‘Yes’ and ‘no’ exposure responses were coded to zeros and ones. Missing responses were also coded as zeros. Individual questions and entire categories were weighted as passive, low active, or high active based upon level of engagement. Positive answers to red herring questions were reverse scored. The overall exposure

scale was then calculated by summing the responses for each category, which included: logo score, shelf label score, taste test/cooking demo score, poster score, educational display score, flyer/pamphlet score, booklet score, promotional item score, newsletter score, radio announcement score, worksite score, and school score. This overall scale was further categorized into quartiles, and differences in outcomes based on exposure levels were assessed using linear regression. An exposure scale specifically for PA related materials was also calculated, and was calculated by summing the responses to any material (posters, educational display, flyers, giveaway, or newsletter) specific to PA.

4.3.7 Analysis

Descriptive analyses comparing baseline characteristics of the intervention and comparison groups were conducted using *t*-tests for normally distributed continuous variables, non-parametric Wilcoxon-Mann-Whitney tests for non-normal continuous variables, and chi-square tests for dichotomous variables. This analysis was performed on both the full study sample and the complete-case study sample. Characteristics of respondents lost to follow-up and respondents remaining in the study were also compared. A Material Style of Life (MSL) scale was used as a proxy for socioeconomic status (see Gittelsohn et al, 2006⁷⁵ for details). This scale consisted of 21 household items such as (e.g. TV, refrigerator, automobile), and respondents answered ‘yes’ or ‘no’ to whether they owned each item in working condition.

The original OPREVENT intervention was designed as a community-randomized controlled trial, and powered for eight communities. However, the intervention was only implemented in five communities due to budgetary constraints. Because of this, it is unlikely that randomization was achieved and therefore a quasi-experimental analysis approach was taken and intervention impacts were assessed using the difference-in-differences (DiD) method. Regression analyses were performed on each variable of interest with time, intervention assignment

(Immediate Intervention or Delayed Intervention), and the interaction term time*intervention as covariates, with clustering at the community level to account for potentially decreased between-person variation among individuals living in the same communities.

Days per week, time per week, and MET-min./week engaged in each intensity of PA as well as PA level category were each analyzed using the DiD method to determine if there were greater improvements in respondents randomized to Immediate Intervention as compared to Delayed Intervention communities. Sub-analyses were then performed to determine whether the change in PA outcomes differed by exposure to intervention (overall exposure and PA-specific exposure), employment status, sex, age (above or below mean age of 44.5 years), or baseline BMI category (underweight BMI $\leq 17.9 \text{ kg/m}^2$, normal weight BMI 18-24.9 kg/m^2 , overweight BMI 25-29.9 kg/m^2 , obese class I BMI 30-34.9 kg/m^2 , obese class II BMI 35-39.9 kg/m^2 , or obese class III BMI $\geq 40 \text{ kg/m}^2$). All alphas were set at 0.05.

4.4 Results

Data were collected on a total of 424 respondents at baseline, of which 71% (n=299) completed both baseline and follow-up surveys. Respondents lost to follow-up were younger (41.5 yrs vs. 44.5 yrs), less likely to receive WIC (17.6% vs. 29.2%), and less likely to receive commodity foods (4.9% vs. 13.8%) than those with completed surveys. There were no differences in loss to follow-up between Immediate Intervention and Delayed Intervention groups, or between communities. Responses for 14 respondents were re-coded to zero for reporting activity for less than ten minutes duration and responses for 89 respondents were truncated to 180 min/day for reporting greater than 180 min/day, according to the IPAQ Guidelines^{35,88,103}.

The evaluation sample consisted of respondents completing both the baseline and follow-up surveys. Demographic characteristics of the evaluation sample are presented in **Table 4.1**.

Descriptive analyses of these variables were also performed on the full evaluation sample (n=424), however several variables, specifically outcome variables, were found to be significantly different between the intervention and comparison groups at baseline (age, current smoker, WIC recipient, commodity food recipient, food bank recipient, number of days walking in last seven days for at least ten minutes, met criteria 2 for moderately active, met criteria 2 for high active), and therefore only respondents with both baseline and follow-up surveys were used for the analysis.

The evaluation sample was predominately female (70.8%) with an average age of 44.5 years. Respondents reporting that a medical professional had ever told them that they were obese was 44.8%, which is consistent with the CDC's recent estimate of 42.3% in AIAN adults 18 years and older^{25,35,102,104}. However, prevalence of obesity as estimated by our BMI measurements was slightly higher, at 55.2%. Participation in the Supplemental Nutrition Assistance Program (SNAP) was estimated to be 50.2%, which is much greater than previous estimates of 24%^{35,96,102,105-109} in the general AI population. Total number of people living in each household, percent of respondents who were the main food preparer within their household, percent of respondents with a tech school degree, percent having some college education, household size, SNAP recipient, commodity food recipient, and Senior Center meal recipient were significantly different between the Immediate Intervention and Delayed Intervention groups at baseline.

4.4.1 Exposure to intervention

Overall exposure to intervention activities was significantly greater in Immediate Intervention communities than Delayed Intervention communities for each intervention component; however, it was still low at only 59.3 out of a possible 170 points (**Table 4.2**). The highest exposures were reported for shelf-labels (8.7 out of 20 points) and posters (7.2 out of 14 points), while the lowest exposures were reported for newsletters (1.9 out of 8 points) and radio

announcements (0.6 out of 5 points). Exposure to the worksite component, where the majority of PA related activities were implemented, was low at only 4.2 out of 16 points. Only three respondents reported participating in a Pedometer Challenge. Exposure to PA-specific materials was intermediate (8.8 out of 16 points).

4.4.2 Frequency – *Days engaged in physical activity*

There were no significant differences in days per week engaged in PA observed when comparing change in Immediate Intervention to change in Delayed Intervention (**Table 4.3**). Individuals in all communities spent more days per week engaged in walking than any other intensity of PA, at both baseline and follow-up. Change in number of days per week engaged in walking, moderate, and vigorous activity was positive in both Immediate Intervention and Delayed Intervention communities. The change from baseline to follow-up was slightly greater in the Immediate Intervention communities as compared to the Delayed Intervention communities for days per week engaged in moderate and vigorous activity, while it was slightly lower for days per week engaged in walking.

Change in days per week engaged in in any type of PA did not differ significantly by overall exposure to intervention, PA-specific exposure, employment status, sex, age above or below the mean age of 44.5 years, or baseline BMI category.

4.4.3 Duration – *Time engaged in physical activity*

There were no significant differences in change in minutes per week engaged in PA or change in minutes per week spent sitting observed when comparing change in Immediate Intervention to change in Delayed Intervention (**Table 4.4**). Individuals in all communities spent more minutes per week engaged in moderate intensity PA than either walking or vigorous intensity PA at both baseline and follow-up. In the Immediate Intervention communities, time engaged in walking, moderate, and vigorous PA all decreased, while time spent sitting actually

increased slightly. In the Delayed Intervention communities, time engaged in walking increased while time engaged in moderate PA decreased and time engaged in vigorous PA stayed the same. Similar to the Immediate Intervention communities, time engaged in sitting also slightly increased in the Delayed Intervention communities.

Change in time per week engaged in in any type of PA did not differ significantly by overall exposure to intervention, PA-specific exposure, employment status, sex, age above or below the mean age of 44.5 years, or baseline BMI category. However, changes in time per week engaged in walking and moderate activity both trended towards significance among participants within the third quartile of exposure (data not shown).

4.4.4 Volume – *MET-min./week engaged in physical activity*

There were no significant differences in MET-min./week engaged in PA observed when comparing change in Immediate Intervention to change in Delayed Intervention (**Table 4.5**).

Individuals in the intervention communities had the highest MET-min./week engaged in moderate and vigorous intensity PA at both baseline and follow-up, while the respondents in the Delayed Intervention communities had the highest MET-min./week engaged in moderate intensity PA at both baseline and follow-up. In the Immediate Intervention communities, MET-min./week engaged in walking, moderate, and vigorous PA all decreased. In the Delayed Intervention communities, MET-min./week walking and vigorous PA increased while MET-min./week moderate PA decreased.

Change in MET-min./week engaged in any type of PA did not differ significantly by overall exposure to intervention, PA-specific exposure, employment status, or sex. Change in MET-min./week engaged in walking was significantly negative among overweight ($p=0.025$) as well as those above the mean age of 44.5 years ($p=0.026$). Change in MET-min./week engaged in moderate PA was significantly negative among obese class III ($p=0.045$) individuals.

4.4.5 Physical activity levels

There were large changes in meeting the criteria for low and moderate PA level categories from baseline to follow-up in the Immediate Intervention communities (**Table 4.6**). This shift from low to moderate was primarily accomplished via a large shift in individuals meeting the second criterion for the moderately active category: greater than or equal to five days of moderate-intensity activity and/or walking of greater than or equal to 30 minutes per day.

Satisfaction of criterion 3 (≥ 5 days of any combination of walking, moderate-intensity or vigorous intensity activities achieving a minimum total PA of at least 600 MET-min./week) was the most common method for individuals to be categorized as moderately active in both Immediate Intervention and 2 communities at baseline and follow-up. Satisfaction of criterion 1 (vigorous-intensity activity on ≥ 3 days achieving a minimum total physical activity of ≥ 1500 MET-min./week) was the most common method for individuals to be categorized as high active in both Immediate Intervention and 2 communities at baseline and follow-up.

4.5 Discussion

This is the first study to examine changes in PA outcomes resulting from implementation of a MLMC obesity intervention in AI adults. We found that an MLMC adult obesity intervention implemented in three AI communities over one year did not significantly improve PA outcomes within our evaluation sample, although there was a large shift from low active to moderately active PA levels in the Immediate Intervention communities. In the Immediate Intervention communities, the percent meeting criteria for moderately active increased from 28.6% to 45.1%. A key guideline in the 2008 PAG is that some PA is better than none³², and these results certainly support that a large percentage of our evaluation sample transitioned from low active, which also included sedentary behavior, to moderately active.

Individuals in the Immediate Intervention communities exposed to the intervention did not demonstrate greater changes in frequency (days per week), duration (time per week), or volume (MET-min. per week) engaged in any intensity of PA as compared to individuals in Delayed Intervention communities who were not exposed to the intervention. Overall exposure to the intervention was low, as was exposure to the PA-specific intervention materials and activities, and level of exposure did not modify intervention outcomes.

Other adult obesity interventions promoting PA in AI adults have shown mixed results. In 2009, Teufel-Shone et al.^{35,103,104} published a systematic review of PA interventions implemented within AI and Alaska Native populations across the U.S. and Canada. The interventions chosen for review varied widely in location, target audience, objectives and strategies, and impact and evaluation measures. Of the 64 interventions reviewed, 20.3% targeted the community, similar to OPREVENT^{35,104,110}. Seventy-five percent aimed to change environmental resources and strategy, and 34.4.% were culturally adapted^{35,105-110}, also like OPREVENT. Only 42.2% reported on program impact on participant health, fitness, weight, health knowledge, or frequency of PA, and of these only 41% reported statistically significant *p*-values^{35,109-112}. Only three of the evaluated interventions reported significant increases in respondents' frequency of PA^{35,70,104,113,114}. These studies did not use the same PA assessment methods as OPREVENT (IPAQ-SF); however, baseline time spent walking can be compared between the OPREVENT evaluation sample and that from Witmer et al. (2004)^{70,110,113}. Approximately 50% of the sample evaluated by Witmer et al. (2004) reported walking for more than one hour per week^{43,110,115,116}, while 100% of the OPREVENT evaluation sample reported walking for more than one hour per week. This comparison suggests that the respondents in the OPREVENT evaluation sample may have been over-reporting at baseline, though it is important to note that the study by Witmer et al. (2004) was conducted in women only with a sample size of 18¹¹⁰.

Since 2009, results from an additional MLMC adult obesity intervention targeting nutrition and PA behavioral change in Canadian First Nations communities have been published.

Like OPREVENT, this program consisted of worksite, food store, and media components that were implemented in several phases over a one-year time period^{70,113,114,117,118}. Pedometer challenges and walking clubs were promoted throughout, and community events such as walking workshops, hikes, community dances, fitness classes, and family activities such as relay games and sporting events were also encouraged^{70,88,113,114}. Unfortunately, the impact of this program on PA has yet to be published, and therefore no comparisons can be made.

4.5.1 Limitations

There are several limitations to this analysis. One limitation is that an objective measure of PA was not used in addition to the IPAQ-SF. Using pedometers to measure step counts would aid in verifying the data collected via the IPAQ-SF. However, pedometers do not account for non-ambulatory PA (such as resistance training or rowing a canoe), nor do they discriminate between intensities of PA⁴³. There is also potential for user error associated with proper wearing of the pedometer, and because there is no data storage capacity there would still be the opportunity for recall bias associated with the recording of daily step counts by respondents⁴³.

Some researchers are beginning to use accelerometers to measure PA; however, there are similar limitations in that they are unable to account for non-ambulatory PA nor differentiate between walking surfaces or changes in incline^{89,117,119-121}. There is also the added challenge of developing consistent cut points and regression equations to predict the metabolic costs of activities^{32,114,117,118}. The IPAQ-SF used in this study is designed primarily for population surveillance of physical activity among adults aged 15 – 69 years old^{88,114,116,122,123}. Use as an evaluation tool in intervention studies was not the intended purpose of the IPAQ, and although this is becoming more common in the literature, it is not recommended as an outcome measure in small-scale interventions^{86,88-90}. Additionally, these questionnaires are subjective in nature and rely on accurate participant recall^{86,89,120,124}.

It is also possible that respondents did not have a good understanding of the questions in the IPAQ-SF. Time, frequency, and intensity estimates of PA can be a difficult for data collectors to explain, and equally difficult for respondents to understand. Anecdotal reports from data collectors in the field indicate that the IPAQ-SF was difficult to administer and was met with many questions. Without a solid understanding, respondents may have over-reported PA at baseline, and then estimated correctly at follow-up after learning about PA throughout the intervention; thus making it unlikely to observe positive changes from baseline to follow-up. In fact, 57 respondents over-reported minutes spent engaged in at least one type of PA at baseline, while only 32 over-reported these measures at follow-up. Additionally, frequency, duration, and volume of PA were significantly higher in the Immediate Intervention group at baseline ($p<0.01$, $p<0.05$, and $p<0.01$, respectively), possibly due to over-estimating or misunderstanding of the questions on the IPAQ-SF. This could have limited the ability to observe significant positive changes in these outcomes as compared to the Delayed Intervention group. While we do not have any data that captures knowledge and understanding of PA measures in respondents to assess what may have caused this over-reporting, we can observe in the data that baseline estimates of volume of PA (MET-min./week) well exceeded the recommended range of 500-1,000 MET-min./week for health benefits and weight loss (**Table 5**)³², yet over half of the evaluation sample was classified as obese. This suggests that comprehension may have been poor at least at baseline and over-reporting occurred.

We did not purposefully select individuals deemed to be more likely to participate in promotional activities for PA, specifically the pedometer challenges, for our evaluation sample, such as those employed at participating worksites. Studies have shown that team-based exercise competitions can result in greater percent weight loss and greater daily step changes, and that having a greater percent of teammates and reports of higher social influence result in greater percent weight loss^{43,116,122,123,125-127}. The OPREVENT intervention established teams within worksites to participate in the pedometer challenges. However, due to the randomized evaluation

sample selection method, we did not purposefully select and evaluate individuals who had participated in the worksite pedometer challenge, and in fact only three individuals reported that they had participated.

A review on pedometer use to increase PA and improve overall health by Bravata et al (2007)^{86,90,125,127,128} found that having a step goal was a key predictor of increased PA, and that studies not requiring a step goal did not significantly increase PA over baseline. While the OPREVENT intervention did encourage goal setting for success, specific step goals were not promoted. This same review also found that having an intervention somewhere other than the worksite predicted success^{53,86,124,129}, and it has been suggested that worksite interventions may attract those who are already active^{36,116,130-134}, therefore decreasing the probability of observed change in PA levels. The OPREVENT intervention was implemented community-wide, however PA was specifically emphasized within the participating worksites. Additionally, the intervention did have a primary focus on nutrition, and nutrition was emphasized more in intervention materials and activities throughout the communities.

A primary limitation for this analysis was that the original study design was powered for a community-randomized controlled trial among eight AI tribes, yet this was reduced to five. This resulted in a smaller evaluation sample and the inability to run analyses based on a randomized design. The DiD analysis method for quasi-experimental studies was used, but the trial essentially became a pilot-study. A key assumption of the DiD method is the parallel paths assumption, which suggests that the average change in the control, or comparison, group represents the change that would also occur in the treatment group if there was in fact no treatment. This is known as the counterfactual. For this to be true, the pre-treatment trends for both groups should be the same. We were unable to confirm this in our evaluation sample, as we only have one pre-treatment measurement for each individual and several pre-treatment measurements would be needed to establish a trend. Therefore, it is possible that our DiD estimators are biased. Additionally, PA levels may be more alike in related individuals or those who share a similar

environment, reducing the between-person variation and reducing the likelihood of observing differences^{36,43,125,127,129,135}. We attempted to account for this by clustering at the community level in the DiD regressions, however it is still possible that variability may be underestimated.

Low PA is only one of many principal risk factors for obesity^{3,4,136}. Other important risk factors, including excess energy intake^{21,114}, high fat intake^{18,114}, are beyond the scope of this paper and will be addressed in additional analyses.

4.6 Conclusions

Implementation of a MLMC intervention program in five AI communities did not significantly improve PA outcomes in respondents. Large shifts from low active to moderately active PA levels were observed in the Immediate Intervention communities. Change in overall study design from community-randomized controlled trial to quasi-experimental pilot-study, low exposure to the worksite component, essentially zero participation in the Pedometer Challenges, and data collection instrument choice all may have influenced our ability to observe improvements in PA outcomes. Moving forward, it will be essential to work closely with all tribes in an effort to discourage and prevent attrition. Because the PA literature is rapidly developing as more research is conducted and new recommendations are formed, it is important that researchers review the literature before intervention development to ensure that evidence-based messages are being promoted and appropriate data collection methods are being used. It will also be necessary to increase the intensity of intervention delivery, with an emphasis on PA. Based on these results, it is recommended that PA be emphasized within each component of an MLMC intervention, as well as for the entire duration of the program as opposed to just one or two particular phases. These findings will be used to inform the development and implementation of OPREVENT2, which is in the planning and development phase and will be implemented in six different AI communities.

4.7 Acknowledgements

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Table 4.1: Sociodemographic characteristics of the IPAQ evaluation sample at baseline (n=299)

Characteristics	Immediate Intervention (n=182)	Delayed Intervention (n=117)
Female (%)	69.6	72.7
Age (y)	45.2 ± 14.0	43.3 ± 12.6
Education (%)		
High school	22.9	29.1
Tech School	8.9	2.6*
Some college	33.0	16.2*
College	2.2	2.6
Graduate School	0.0	0.0
Married (%)	31.3	34.8
Household size (n)	3.5 ± 2.0	4.3 ± 2.4*
Current smoker (%)	24.3	34.0
History of disease (%)		
Obesity	47.2	41.1
Heart disease	8.5	8.8
High blood pressure	32.4	30.7
Type 2 diabetes	20.5	25.4
Not employed (%) [†]	41.2	44.4
Food assistance (%)		
WIC ^a	14.4	22.4
SNAP ^b	43.1	61.2*
Commodity	18.2	6.9*
Senior Center	15.5	3.5*
Food Bank	5.5	11.2
MSL ^c	12.8 ± 4.5	13.8 ± 5.0
BMI ^d (kg/m ²)	32.3 ± 7.7	32.0 ± 8.1
Overweight (%)	28.9	29.1
Obese (%)	57.2	52.1

*Significantly different from Immediate Intervention group at baseline

[†]Includes unemployed, retired, and disabled

^aWomen, Infants, and Children

^bSupplemental Nutrition Assistance Program

^cMaterial Style of Life (scale used as proxy for socioeconomic status)

^dBody Mass Index

Table 4.2: Exposure Scales

Exposure Category	Possible Range	Immediate Intervention (n=118)	Delayed Intervention (n=83)	p-value
1. Logo	0 – 5	3.5 ± 1.0	0.7 ± 1.2	< 0.05
2. Shelf Labels	0 – 20	8.7 ± 6.1	0.5 ± 2.2	--
3. Taste Test & Cooking Demonstration	0 – 27	3.6 ± 2.8	0.2 ± 1.1	< 0.05
4. Poster	1 – 14	7.2 ± 4.2	0.2 ± 0.9	<0.05
5. Educational Display	-2 – 12	2.8 ± 1.6	0.1 ± 0.6	<0.05
6. Flyers	-1 – 20	4.6 ± 3.1	0.1 ± 0.8	<0.05
7. Booklet	0 – 12	4.1 ± 2.4	0.1 ± 0.7	<0.05
8. Giveaway	0 – 14	3.2 ± 2.4	0.1 ± 0.6	<0.05
9. Newsletter	0 – 8	1.9 ± 1.9	0.0 ± 0.2	<0.05
10. Radio	0 – 5	0.6 ± 1.5	0.1 ± 0.7	<0.05
11. School	0 – 17	3.5 ± 6.1	0.2 ± 1.0	<0.05
12. Worksite	0 – 16	4.2 ± 5.6	0.4 ± 1.5	<0.05
Composite scores:				
Food Store ^a	0 – 47	27.3 ± 12.3	0.6 ± 2.6	<0.05
Physical Activity ^b	0 – 16	8.8 ± 5.1	0.3 ± 1.3	<0.05
Overall Exposure ^c	-1 – 170	59.3 ± 25.4	3.3 ± 7.8	<0.05

^aSum of categories #2 and #3^bSum of exposure to all physical activity related promotional materials within all categories^cSum of all exposure categories, #1-12

Table 4.3: Frequency – days per week engaged¹ in each intensity of physical activity (PA): baseline, follow-up, and difference-in-differences (DiD) in Delayed Intervention (D) and Immediate Intervention (I) OPREVENT communities

	Baseline			Follow-up			DiD	p-value
	D	I	Difference	D	I	Difference		
Walking	3.5 ± 2.6	4.1 ± 2.5	0.6 ± 0.6	4.6 ± 2.7	4.8 ± 2.5	0.2 ± 0.8	-0.4 ± 0.9	0.684
Moderate PA	3.7 ± 2.5	3.6 ± 2.3	-0.0 ± 1.0	4.3 ± 2.5	4.5 ± 2.5	0.1 ± 0.5	0.2 ± 1.2	0.880
Vigorous PA	1.7 ± 2.0	2.6 ± 2.4	0.9 ± 0.5	2.2 ± 2.4	3.4 ± 2.8	1.2 ± 0.6	0.2 ± 0.7	0.781
Moderate and Vigorous PA	5.4 ± 3.6	6.1 ± 4.2	0.8 ± 1.2	6.6 ± 4.2	7.9 ± 4.6	1.3 ± 1.2	0.5 ± 1.8	0.785

¹Does not include responses of less than ten minutes of PA

Table 4.4: Duration – Time engaged¹ in each intensity of physical activity (PA): baseline, follow-up, and difference-in-differences (DiD) in Delayed Intervention (D) and Immediate Intervention (I) OPREVENT communities (min./day)

	Baseline			Follow-up			DiD	p-value
	D	I	Difference	D	I	Difference		
Sitting	260.8 ± 225.5	256.7 ± 236.0	-4.1 ± 166.4	272.4 ± 199.7	238.0 ± 206.6	-34.4 ± 116.9	-30.3 ± 62.0	0.651
Walking	42.2 ± 50.1	50.1 ± 52.6	7.9 ± 12.7	42.8 ± 51.5	36.7 ± 55.6	-6.1 ± 14.8	-14.0 ± 10.7	0.261
Moderate PA	53.6 ± 53.8	56.4 ± 50.7	2.9 ± 20.3	45.5 ± 51.0	44.3 ± 44.6	-4.1 ± 8.1	-4.1 ± 8.1	0.642
Vigorous PA	28.7 ± 46.1	42.7 ± 48.2	14.1 ± 12.9	27.3 ± 39.5	30.8 ± 40.1	-10.5 ± 12.5	-10.5 ± 12.5	0.448
Moderate and Vigorous PA	83.9 ± 79.1	99.6 ± 82.7	15.7 ± 31.8	71.7 ± 75.9	76.0 ± 71.4	4.3 ± 26.8	-11.4 ± 19.7	0.593
All PA ^a	94.8 ± 70.5	111.5 ± 77.4	16.7 ± 18.8	81.5 ± 69.1	87.1 ± 66.0	5.6 ± 19.2	-11.2 ± 14.6	0.489

¹Does not include responses of less than ten minutes of PA

^aIncludes walking, moderate PA, and vigorous PA

Table 4.5: Volume –MET-min./week engaged in each intensity of physical activity (PA): baseline, follow-up, and difference-in-differences (DiD) in Delayed Intervention (D) and Immediate Intervention (I) OPREVENT communities

	Baseline			Follow-up			(DiD)	p-value
	D	I	Difference	D	I	Difference		
Walking	630 ± 969	794 ± 1025	163 ± 282	781 ± 1166	600 ± 838	-181 ± 250	-344 ± 179	0.127
Moderate PA	953 ± 1266	999 ± 1259	46 ± 550	911 ± 1257	834 ± 1090	-78 ± 338	-123 ± 247	0.644
Vigorous PA	663 ± 1468	1345 ± 2164	682 ± 583	694 ± 1214	1050 ± 1720	356 ± 240	-327 ± 557	0.598
Moderate and Vigorous PA	1660 ± 2256	2339 ± 2994	679 ± 1036	1598 ± 1964	1917 ± 2421	318 ± 531	-361 ± 767	0.663
All PA	2287 ± 2784	3112 ± 3656	825 ± 1297	2289 ± 2601	2533 ± 2970	244 ± 748	-580 ± 934	0.568

^aIncludes walking, moderate PA, and vigorous PA

Table 4.6: Physical activity level category: baseline, follow-up, and difference-in-differences (DiD) in Delayed Intervention (D) and Immediate Intervention (I) OPREVENT communities (% of evaluation sample)

	Baseline			Follow-up			DiD	p-value
	D	I	Difference	D	I	Difference		
Low active	39.3	42.3	3.0	31.6	24.2	-7.4	-0.1 ± 0.2	0.574
Moderately active	45.3	28.6	-16.7	47.9	45.1	-2.8	0.1 ± 0.1	0.361
Criterion 1 ^a	18.4	38.4	20.0	21.4	30.8	9.4*	-0.1 ± 0.1	0.420
Criterion 2 ^b	23.5	31.9	8.4	37.8	48.4	10.7	-0.0 ± 0.1	0.882
Criterion 3 ^c	72.4	76.1	3.6	81.6	86.2	4.5	-0.0 ± 0.2	0.956
High active	15.4	29.1	13.7	20.5	30.8	10.3*	-0.0 ± 0.1	0.733
Criterion 1 ^d	18.4	38.4	20.0	24.5	35.2	10.7*	-0.1 ± 0.1	0.526
Criterion 2 ^e	4.1	10.9	6.8	5.1	7.5	2.4	-0.0 ± 0.1	0.455

*Significantly different between control and intervention

^a≥3 days of vigorous-intensity activity of ≥20 min./day

^b≥5 days of moderate-intensity activity and/or walking of ≥30 min./day

^c≥5 days of any combination of walking, moderate-intensity or vigorous intensity activities achieving a minimum total physical activity of at least 600 MET-min./week

^dVigorous-intensity activity on ≥3 days achieving a minimum total physical activity of ≥1500 MET-min./week

^e≥7 days of any combination of walking, moderate-intensity or vigorous-intensity activities achieving a minimum total physical activity ≥3000 MET-min./week

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CHAPTER 5: IMPACT OF OPREVENT ON DIETARY INTAKE

5.1 Abstract

American Indian (AI) populations are disproportionately affected by overweight, obesity, and other diet-related chronic diseases. The Obesity Prevention Research and Evaluation of Intervention Effectiveness in Native North Americans (OPREVENT) project developed to address this burden. The OPREVENT project was a multi-level, multi-component (MLMC) adult obesity intervention that took place within food stores, schools, and worksites in five AI communities in Michigan and New Mexico. Intervention content aimed to change the food-purchasing environment, improve nutritional intake, and increase physical activity (PA) among community members. Semi-quantitative food frequency questionnaires (QFFQs) were conducted at baseline and follow-up. Difference-in-differences analysis was used to determine whether respondents evaluated in the Immediate Intervention communities (n=3) had increased intake of intervention promoted foods and beverages and decreased intake of discouraged foods and beverages as compared to respondents evaluated in the Delayed Intervention (n=2) communities. Usual portion size and daily servings for QFFQ items were assessed. The intervention significantly decreased daily servings of regular soda by 7oz in Immediate Intervention communities as compared to Delayed Intervention communities ($p<0.05$). Overall exposure was low. Results indicated that large MLMC obesity interventions can be successful in reducing intake of regular soda. This is especially important within the context of today's food environment where sugar-sweetened beverages are now the primary source of added sugars in the typical American diet. Failure to observe additional dietary improvements suggests that future research focus on increasing intervention exposure.

5.2 Introduction

A recent report from the United States Department of Agriculture's (USDA) Economic Research Service (ERS) estimated that in the year 2000, Americans were consuming an average of just under 2,700 calories per person per day¹. This was a 24.5% increase from 1970, of which grains (primarily refined grain products) contributed 9.5 percentage points, added fats and oils contributed 9.0 percentage points, and added sugars contributed 4.7 percentage points. Fruits and vegetables together only contributed 1.5 percentage points. Additionally, sugar-sweetened beverages (SSBs) are now the primary source of added sugars in the typical American diet^{2,3}. These data show that not only are Americans today eating over 500 calories more per day on average than they were just 30 years ago, but that those excess calories are coming from foods that do not fit within the current recommendations for a healthy eating pattern from the 2015 – 2020 Dietary Guidelines for Americans⁴. In line with this trend, prevalence of obesity has also increased within this same timeframe, rising from 13.4% to 35.7% in adults aged 20 and older^{5,6}. Prevalence of obesity is even higher in American Indian and Alaska Native (AIAN) populations, with 42.3% of adults age 18 and over classified as obese⁷.

Trends in dietary intake for AIAN adults are similar to those observed in the U.S. general population, including excess energy intake⁸ and high fat intake⁹. Several studies conducted in various tribal communities have described AI diets as being high in fat¹⁰⁻¹², low in fruit and vegetable intake¹³, and characterized by high quantities of high-fat or empty calorie foods such as fry bread, home-fried potatoes, bacon, sausage, and soft drinks¹⁰.

Unfortunately, many of the foods that are being eaten in excess are also associated with increased adiposity and related comorbidities such as type 2 diabetes and heart disease. Red meat and processed meat, such as bacon and sausage, are associated with increased risk of heart disease and type 2 diabetes¹⁴⁻¹⁷. In long-term studies, refined carbohydrates such as white flour (used in fry bread), sugary beverages, and potatoes are associated with overeating, weight gain, type 2 diabetes, and heart disease¹⁷⁻²⁰. Sugar sweetened beverages alone have been found to increase the risk of weight gain, obesity, type 2 diabetes, and even heart disease^{17,21-23}. Additional

research has also shown that individuals who increase their intake of whole grains and fruits and vegetables gain less weight in the long-term than those who do not^{17,24}.

Several obesity interventions with a focus on improving dietary intake have taken place in AIAN communities, but results have varied and success has been limited²⁵⁻³³. Additionally, these interventions operated at selected levels and institutions within the communities, and did not utilize a comprehensive multi-level, multi-component (MLMC) approach to influence the overall environment. An MLMC approach influences the food and nutrition environment at multiple levels within a community, such as food stores, worksites, and schools. This allows for maximum intervention exposure, as participants will encounter intervention activities and messages at several levels within their environment, which reinforces the behavior(s) being promoted^{31,32,34,35}. The lack of conclusively successful interventions and the scarcity of (MLMC) programs in the literature demonstrate the need for additional research.

The Obesity Prevention and Evaluation of InterVention Effectivenss in NaTive North Americans (OPREVENT) pilot-study was developed to address this gap. Founded on both Social Cognitive Theory and the Social Ecological Model, the program sought to address the issue of obesity using a community-centered approach that targeted multiple levels within the environment using a MLMC design.

The objective of this analysis is to 1) describe usual portion sizes and frequencies for discouraged foods, promoted foods, and fruits and vegetables at baseline; 2) report on the impact of OPREVENT on daily servings of discouraged foods, promoted foods, and fruits and vegetables; and 3) determine whether level of exposure to OPREVENT influenced impact. It was hypothesized that participants in intervention communities would increase consumption of intervention promoted foods and beverages and decrease consumption of intervention discouraged foods and beverages from baseline to follow-up as compared to participants in the comparison communities, and that participants reporting high exposure to the intervention would demonstrate greater improvements in dietary intake.

5.3 Methods

5.3.1 Study Design and Setting

The OPREVENT study was a community-randomized controlled MLMC obesity intervention pilot-study with food store, worksite, school, and media components implemented in six phases over one year. A detailed description of the intervention can be found in **Chapter 4**. The OPREVENT program sought to improve dietary intake via education, promotional activities such as food store and worksite taste tests and cooking demonstrations, and partnerships with community organizations to support a healthier food environment. Formative research led to the identification of problem foods, or foods that community members believed contributed to the health and nutritional related links to overweight and obesity within their communities. Study staff worked with community members to determine acceptable and affordable healthier alternatives to these problem foods, and these alternatives were then promoted throughout the intervention. Promoted dietary messages included eating more fruits and vegetables, increasing fiber intake, replacing SSBs with sugar-free alternatives, and swapping out refined grains for whole grains.

5.3.2 Study Population, Recruitment, and Randomization

Data for this study were collected in five American Indian communities, representing four different tribes, across Michigan and New Mexico. All five tribal communities were considered semi-rural or rural, and distance to towns with population over 8,000 ranged from five to 70 miles. To be eligible for the OPREVENT program, tribal communities were required to have an on-reservation population of at least 500, an on-reservation school, at least one on-reservation food store (grocery store, supermarket, or convenience store), and at least one worksite with no less than five tribal member employees. Availability of physical activity (PA)

facilities varied between the communities. More rural reservations had only their own tribal-owned and operated fitness centers, while residents on reservations with greater proximity to larger non-tribal communities were able to benefit from commercial fitness centers.

Communities were stratified by location, relative isolation, local resources, and language group, and then randomized to receive the intervention first (Immediate Intervention group) or second (Delayed Intervention group). Households in each community were randomly selected from tribal lists. Within each household, one adult between the ages of 18 – 65 years old who had been living in the house for at least the past 30 days was randomly selected. Other inclusion criteria included: tribal member and either the main food shopper or the main food preparer for the household. Exclusion criteria included: currently pregnant or breastfeeding women. If the adult was eligible but declined to participate, enrollment continued with the next household on the list. The aim was to enroll 85 adults randomly selected at baseline from each community, resulting in a total $n = 424$. This resulted in $\alpha = 0.05$ and power = 80% to detect change in percent time engaged in sedentary activity (sitting).

Communities were randomized to Immediate Intervention ($n=3$) or Delayed Intervention ($n=2$). Baseline data were collected in the spring of 2012 and the 12-month intervention was implemented in the three Immediate Intervention communities starting in the summer of 2012. Follow-up data were collected in the fall of 2013 and spring of 2014, after which the Delayed Intervention communities received the OPREVENT program.

Data collectors were tribal community members trained by Johns Hopkins School of Public Health (JHSPH) and fluent in the Native language whenever possible or appropriate. Johns Hopkins School of Public Health graduate students also collected data. Data collection training consisted of several in-person sessions as well as in-service trainings throughout the project to maintain quality of data. Interviews took place in community buildings as well as private homes, depending on the respondents' preferences. The Navajo Nation Human Research Review Board (NNHRRB), Indian Health Service (IHS) Institutional Review Board (IRB), the JHSPH IRB, and

individual participating tribal councils approved the study. Signed consent was obtained from all respondents.

5.3.3 Data Collection and Instruments

Data Collection. Trained data collectors collected all data via in-person interviews. Baseline data were collected during the summer of 2011, and follow-up data were collected 24 – 27 months later in the fall of 2013 and the spring of 2014. Participants provided consent prior to each interview. Interviews took approximately 90 – 120 minutes to complete, and all participants received \$40 gift cards to Wal-Mart for their participation after each interview session.

Instruments. Data collection instruments included the Adult Impact Questionnaire (AIQ), the Dietary Assessment Questionnaire (DAQ), which consisted of a brief Semi-quantitative Food Frequency Questionnaire (QFFQ) and quantitative 24-hr recall, and the Intervention Exposure Evaluation (IEE). The AIQ and DAQ were completed at both baseline and follow-up, while the IEE was completed only at follow-up. Data for this analysis were obtained from all instruments at both baseline and follow-up.

Dietary Assessment Questionnaire. The Dietary Assessment Questionnaire (DAQ) consisted of a brief Semi-quantitative Food Frequency Questionnaire (QFFQ) and a quantitative 24-hr recall. Data from the 24-hr recall were incomplete and unable to be evaluated. The QFFQ data were used for this analysis.

The QFFQ covered the last 30-days, and consisted of 45 questions that addressed the frequency of consumption of the problem foods and healthier, promoted alternatives identified during the formative research phase (**Figure 5.1**). Frequencies were reported using eight categories ranging from ‘Never’ to ‘Two or three times a day, and amounts were reported using familiar household units (such as plates, bowls, and spoons) or food models representing locally available portion sizes^{36,37}.

Adult Impact Questionnaire. The AIQ consisted of 15 sections, with questions related to PA habits, environmental factors, psychosocial constructs such as self-efficacy, food and health knowledge, and social support (data presented elsewhere). The final section of the AIQ collected sociodemographic information, including age, sex, household size, marital status, educational level, employment status, current smoking status, personal and family history of chronic disease, and food-assistance program participation.

Intervention Exposure Evaluation. The Intervention Exposure Evaluation (IEE) was completed at follow-up only. It consisted of 11 sections to measure type and amount of exposure to the intervention. Categories included: 1) OPREVENT Logo; 2) Shelf Labels; 3) Taste Tests; 4) Posters and Educational Displays; 5) Flyers and Booklets; 6) Store Visits; 7) Giveaways; 8) OPREVENT Newsletter; 9) Radio Announcements; 10) OPREVENT School Activities; and 11) OPREVENT Worksite Activities. Interviewers read the following instructions to the respondents: “We would like to ask you if you have seen materials related to the OPREVENT program. Our main goal is to hear about your experiences and your opinions. There are no right or wrong answers. We are (I am) only here to gather information. I am now going to ask you about or show you some pictures of materials or activities that might have been part of the OPREVENT program in your community.” Respondents answered ‘yes’ or ‘no’ to each question. A third option, ‘Not Applicable: did not recognize any materials,’ was not read aloud to the participant as a valid response and was used as a last resort if probing attempts had failed.

5.3.4 Data Management

At baseline, copies of the data collection instruments were sent to the project’s Data Manager at JHSPH in Baltimore, Maryland where they were reviewed for completeness before graduate students entered the AIQ and QFFQ data into Microsoft Access databases and Microsoft Excel spreadsheets (Microsoft Corporation). At follow-up, copies of all data collection

instruments (AIQ, DAQ, plus IEE) were sent to the project's Data Manager at JHSPH in Baltimore, Maryland for processing. Graduate students entered the AIQ, QFFQ, and IEE data into a Microsoft Access database and Microsoft Excel spreadsheets (Microsoft Corporation). Finally, all data were then exported to Stata software, version 12.1 (StataCorp) for analysis.

Outliers were identified using the Tukey Method and removed if they were deemed to be influential. Missing data were dropped from analyses, and were not imputed due to the small sample size and the potential for large error related to the assumptions of imputation.

5.3.5 QFFQ Variable Creation

Respondents' typical portion sizes and 30-day frequencies were used to calculate total servings of each food item for the 30-day period. Daily servings were calculated by dividing the 30-day total by 30.

5.3.6 Scoring of the Intervention Exposure Evaluation

The IEE was scored and used to create an overall exposure scale using similar protocol as used in previous studies conducted in AI populations^{30,38,39}. All 'Yes' and 'no' exposure responses were coded to zeros and ones, and missing responses were coded as zeros. Weights were assigned to individual questions and entire categories based on whether they were categorized as passive, low active, or high active level of engagement. Any positive answers to red herring questions were reverse scored. The scored responses from the following categories were summed to create an overall exposure scale: logo score, shelf label score, taste test/cooking demo score, poster score, educational display score, flyer/pamphlet score, booklet score, promotional item score, newsletter score, radio announcement score, worksite score, and school score. Differences in outcomes based on exposure levels were assessed by quartile of exposure using linear regression.

5.3.7 Analysis

Descriptive analyses to compare baseline characteristics of the Immediate Intervention and Delayed Intervention groups were conducted. Students *t*-tests were used for normally distributed continuous variables, non-parametric Wilcoxon-Mann-Whitney tests were used for non-normal continuous variables, and chi-square tests were used for dichotomous variables. This analysis was performed on both the full study sample and the complete-case study sample, as well as to compare respondents lost to follow-up to respondents remaining in the study at completion. A Material Style of Life (MSL) scale, an additive 21-item scale based on the number of certain household items owned by the respondent, was used as a proxy for socioeconomic status (see Gittelsohn et al, 2006⁴⁰ for details). A Material Style of Life (MSL) scale was used as a proxy for socioeconomic status (see Gittelsohn et al, 2006⁴⁰ for details). Respondents answered ‘yes’ or ‘no’ to whether they owned each item (e.g. TV, automobile, computer) in working condition.

Because the original OPREVENT program was designed for eight communities, and only five remained in the study, it is unlikely that randomization was achieved. To account for this, the study was determined to be quasi-experimental and intervention impacts were assessed using the difference-in-differences (DiD) method. Regression analyses were performed on each variable of interest with time, intervention assignment (Immediate Intervention or Delayed Intervention), and the interaction term time*intervention as covariates, with clustering at the community level to account for potentially decreased between-person variation among individuals living in the same communities.

Total and daily serving of promoted foods, discouraged foods, and fruits and vegetables were each analyzed using the DiD method to determine if there were greater improvements in respondents randomized to Immediate Intervention communities. Sub-analyses were then performed to determine whether the changes in dietary outcomes differed by exposure,

employment status, sex, age (above or below mean age of 44.5 years), or baseline BMI category (underweight BMI ≤ 17.9 kg/m², normal weight BMI 18-24.9 kg/m², overweight BMI 25-29.9 kg/m², obese class I BMI 30-34.9 kg/m², obese class II BMI 35-39.9 kg/m², or obese class III BMI ≥ 40 kg/m²). Alphas were set to 0.05.

5.4 Results

Data were collected on a total of 424 respondents at baseline. A total of 299 (71%) completed both baseline and follow-up surveys. Respondents lost to follow-up were found to be younger (41.5 yrs vs. 44.5 yrs), less likely to receive WIC (17.6% vs. 29.2%), and less likely to receive commodity foods (4.9% vs. 13.8%) than those who completed the study. There were no differences in loss to follow-up between Immediate Intervention and Delayed Intervention groups.

The evaluation sample was comprised of respondents who completed both baseline and follow-up surveys. A comparison of baseline sociodemographic characteristics has been described elsewhere (**Chapter 4, Table 4.1**). The majority of the evaluation sample were female (70.8%), and the average age was 44.5 years. Percent of respondents reporting that a medical professional had ever told them that they were obese was high (44.8%), as was prevalence obesity as estimated by our BMI measurements (55.2%). Both estimates are consistent with recent national reports^{7,41-43}. Approximately half of the evaluation sample reported participation in the Supplemental Nutrition Assistance Program (SNAP). At baseline, there were significant differences between the Immediate Intervention group and the Delayed Intervention group in total number of people living in each household, percent of respondents who were the main food preparer within their household, with a tech school degree, percent having some college education, household size, SNAP recipient, commodity food recipient, and Senior Center meal recipient.

5.4.1 Exposure to Intervention

Exposure scores have been presented elsewhere (**Chapter 4, Table 4.2**). To summarize, overall exposure to intervention activities was significantly greater in Immediate Intervention communities than Delayed Intervention communities for each intervention component, however it was still low at only 59.3 out of a possible 170 points. The highest exposures were reported for shelf-labels and posters, and the lowest exposures were reported for newsletters and radio announcements. Exposure to nutrition-specific intervention materials is presented in **Table 5.1**.

5.4.2 Usual Portion Sizes at baseline

Median portion sizes at baseline for all foods and beverages included on the QFFQ are shown in **Table 5.2**. There were very few differences between Immediate Intervention and Delayed Intervention communities. The median usual portion size was larger in Immediate Intervention communities for pizza and nuts, and smaller in Immediate Intervention communities for fruity candy and 2% milk.

5.4.3 Daily Servings at baseline and DiD of Discouraged Foods

Table 5.3 summarizes the daily servings and DiD for daily servings of discouraged foods. Daily servings of processed meat slices such as bologna or salami were significantly greater in the Immediate Intervention communities at follow-up. The discouraged foods with at least half of a serving per day were white bread, fruity candy, and regular soda. Hamburgers, baked potatoes with at least 2 tbsp. added fat, and alcohol were the three foods with the lowest servings per day.

There was a significant DiD estimate for daily servings of regular soda ($p < 0.05$), indicating that daily servings of regular soda decreased more in Immediate Intervention

communities than in Delayed Intervention communities from baseline to follow-up. The DiD for servings of many of the discouraged foods decreased with each quartile of exposure, however there were no significant differences for any food or beverage item. Respondents classified as class III obesity according to their BMIs had significantly greater DiD for daily servings of sugary drinks ($p<0.05$). Female respondents, as well as those below the mean age of 44.5 years, had significantly greater DiD for daily servings of regular soda ($p<0.05$).

5.4.4 Daily Servings at baseline and DiD of Promoted Foods

The daily servings at baseline and DiD for daily servings of promoted foods are shown in **Table 5.4**. Daily servings of game meat were significantly greater in Immediate Intervention communities compared to Delayed Intervention communities at baseline. The promoted foods with at least half of a serving per day were water, 100% whole wheat bread, and eggs. Game meat, fish, and light popcorn were the three foods with the lowest servings per day.

The DiD for game meat was significant, although it was the Delayed Intervention communities that experienced greater change than the Immediate Intervention communities ($p<0.01$). For all other items, there were no significant DiD estimates observed in the overall evaluation sample. There were trends towards significance for fish ($p=0.129$), low-sugar cereals ($p=0.113$), and sugar-free drinks ($p=0.112$). The DiD for servings of promoted foods increased with each quartile of exposure, however there were no significant differences. Respondents below the mean age of 44.5 years had significantly greater DiD for 100% juice ($p<0.01$). Difference-in-differences in daily servings of water was also significantly greater for those classified as normal weight according to their BMIs ($p<0.01$).

5.4.5 Daily Servings at baseline and DiD of Fruits and Vegetables

Table 5.5 summarizes daily servings at baseline and DiD for daily servings of fruits and vegetables. There were no significant intervention effects observed comparing Immediate Intervention and Delayed Intervention communities. Other vegetables, bananas, and other fruit were the three items with the greatest servings per day, while green salad, berries, and dry fruit were the three items with the lowest servings per day. There were no differences observed by exposure, age, sex, state, or BMI category, however daily servings of dark leafy greens did increase with each quartile of exposure in the Immediate Intervention group.

5.5 Discussion

This is the first study to examine changes in dietary intake resulting from implementation of a MLMC obesity intervention in AI adults. We found that AI adults living in Immediate Intervention communities and exposed to the MLMC adult obesity intervention over one year significantly decreased daily consumption of regular sodas in comparison to Delayed Intervention communities. Overall exposure to the intervention was low, but higher degree of exposure to the intervention significantly increased the daily servings of game meat, and significantly decreased daily servings of whole milk.

In Immediate Intervention communities, daily servings went from 14.4oz regular soda at baseline to 7oz regular soda at follow-up, representing a decrease of approximately 7oz of regular soda. A 20oz serving of regular soda contains approximately 250 kcal, all of which come from added sugars. A decrease of 7oz represents a decrease of approximately 87.5 kcal. Keeping all other variables constant, a daily decrease of 87.5 kcal could result in a weight loss of ten pounds per year. For the OPREVENT evaluation sample, with an average weight of approximately 190 pounds, this reduction in soda consumption alone could represent a 5% weight loss, which is considered to be clinically important. It is reasonable to believe that respondents engaging in other health promotion behaviors, including those supported by the OPREVENT intervention,

could achieve a clinically significant weight loss of 10%. This finding is especially pertinent to the literature today as there is an international movement to decrease consumption of added sugars in the form of SSBs, with an emphasis on regular soda.

Consumption of SSBs by adults in the U.S. has increased steadily since the mid-1960s⁴⁴, and has paralleled the nation's increasing obesity prevalence²³. Daily calories from SSBs have increased from 64.6kcal/day to 141.7kcal/day since the late 1970s⁴⁵, and SSBs, primarily regular sodas, are now the primary source of added sugars in the U.S. diet^{2,3}. Similar trends are observed in AI populations. One descriptive study in Native-American women in Oklahoma found that soda was the most frequently reported food on 4-day weighted food records, and that it was the greatest contributor to total added teaspoons of sugar and carbohydrate intake⁴⁶.

Because of the well-established link between added sugar intake and obesity and other diet-related chronic diseases^{21-23,47-51}, the American Heart Association (AHA) suggests limiting added sugars to no more than half of the daily discretionary calorie allowance (approximately 100kcal/day for women and 150kcal/day for men)^{47,52}, and the USDA's 2015 Dietary Guidelines recommends that added sugars not exceed 10% of total caloric intake each day⁴. At follow-up, the Immediate Intervention respondents in the OPREVENT evaluation sample were consuming an average of 90kcal/day from regular soda, which is within range of the AHA's guideline for both men and women.

Change in consumption of other SSBs was not significantly different between Immediate Intervention and Delayed Intervention communities. Although OPREVENT's messages did include decreasing all SSBs, such as sweet tea, energy drinks, and high-sugar powdered drink mixes, the emphasis was on regular soda. Community members specifically identified regular soda as a "problem food" during the formative phase of the project, and therefore discouraging of regular sodas may have overshadowed that of other SSBs.

It is also possible that chance alone led to these results. The OPREVENT intervention focused on nearly 50 different foods and beverages. The fact that significant changes were

observed in daily servings of regular soda but not any other food or beverage is surprising, and therefore it must be considered that these findings are merely coincidental.

Being below the mean age of 44.5 years significantly modified the outcome for daily servings of regular soda and game meat. Younger respondents both decreased their consumption of regular soda and increased their consumption of game meat more than older respondents. Sub-analyses revealed that daily servings of regular soda were significantly higher in younger respondents at baseline, which represents greater potential for change and could explain why greater change was observed in this population. However, the same differences at baseline were not observed for game meat. Another possible explanation is that it is easier for younger individuals to obtain game meat, as they are better able to engage in hunting and trapping activities.

Female respondents had significantly greater change in daily servings of regular soda. Inclusion criteria for the OPREVENT evaluation sample required that respondents be either the primary food shopper or preparer in their household. This role is traditionally fulfilled by women in many of the OPREVENT communities, and as such the evaluation sample was predominately female (69.6% in Immediate Intervention and 72.7% in Delayed Intervention). Additionally, if females were primarily responsible for food shopping, it is likely that they were more exposed to the intervention materials in the food stores, which may lead to greater changes. In fact, the exposure data did show that the highest exposure scores were reported for the food store component (**Table 5.2**).

Daily servings of sugary drinks and water were impacted by respondents' BMI classification, with class III obese respondents reporting significantly greater changes for daily servings of sugary drinks and normal weight respondents reporting greater changes for daily servings of water.

Other adult obesity interventions promoting healthy dietary intake in AI adults have shown similar results in decreased consumption of soda and other SSBs. The Zuni Diabetes

Prevention Program was a six-year intervention that took place on the Zuni Indian reservation in Western New Mexico and targeted multiple risk factors for diabetes and obesity, including low PA and high consumption of SSBs²⁹. A midpoint evaluation of the program revealed a significant decrease in consumption of SSBs, and while the target population was adolescents rather than adults, the findings support the results from OPREVENT. Healthy Foods North (HFN) was a MLMC obesity intervention in a remote First Nations (FN) community in Canada that also discouraged certain unhealthy foods, similar to those discouraged in OPREVENT⁵³. Researchers observed a significant decrease in consumption of unhealthy drinks (including regular pop, sweetened juice, and sweetened drinks such as Tang®, fruit punch, and Kool-Aid®) in the intervention group, going from 754g/day to 587g/day⁵³. This is equivalent to a decrease from 26.6oz/day to 20.7oz/day, or 5.9oz, which is similar to the results obtained in OPREVENT for regular soda alone. A similar study also conducted within a FN reserve reported decreased intake of unhealthy drinks, as well⁵⁴. Finally, the Shape Up Somerville study found that children exposed to the intervention decreased consumption of SSBs by more than 12oz per week, but did not observe any change in fruit and vegetable consumption³⁴. The intervention was a two-year community-based trial within multiple components, much like OPREVENT, and although the target population was children and not AI adults the results corroborate our findings and show the potential of MLMC obesity interventions. Other research assessing dietary intake in AIAN adults following large-scale obesity interventions report changes in energy and macronutrient content, and unfortunately we are unable to obtain those values from this data to allow for a comparison.

5.6.1 Limitations

There are limitations to this analysis. First, there were limitations to the data collection instrument. A validation study for the QFFQ was not conducted within our sample population. The instrument consisted of 45 questions, most of which were grouped items. This can be

cognitively complex for respondents, and assumptions must be made about the relative frequencies of intakes and portion sizes⁵⁵. Grouping items can also lead to underestimation of intake⁵⁶. Food frequency questionnaires are prone to systematic error due to incomplete or inappropriate food lists and difficulty performing cognitively complex memory and averaging tasks. Within-person error also needs to be considered, as individuals may report their diet differently at two different time points, which could lead to a wider distribution and larger standard errors.

The 45 questions on the QFFQ pertained only to frequency of consumption of the problem foods and healthier alternatives that had been identified. Although the problem foods and healthier alternatives were identified by community members during the formative phase, identification was based on their perceptions only and was never confirmed through additional research. It is possible that the foods perceived to be problematic by the formative workshop attendees were not in fact consumed in excess by all community members, and therefore we would not expect to see much change from baseline to follow-up. The same holds true for the healthier alternatives: although workshop attendees identified what they believed to be acceptable healthier alternatives, it is possible that not all community members viewed them as such and were not persuaded to try them by intervention messages and materials. Additionally, the brief QFFQ was not meant to capture the majority of foods consumed by community, but rather only the promoted and discouraged foods. As such, we were unable to assess the contribution of the promoted and discouraged foods to total dietary intake or compare dietary intake to national standards or guidelines such as USDA's MyPlate or the Healthy Eating Index. This may have yielded a more complex analysis and a richer understanding of the dietary changes that may have taken place. Also because of this, we were unable to accurately estimate energy and nutrient intake, which may have revealed other changes. It may be possible to significantly improve dietary intake through decreased total energy intake or percent calories from fat without a significant change in daily servings of different food items, however we are unable to assess this.

We did not purposefully select respondents for our evaluation sample, choosing instead to randomly select respondents from each community. Purposeful selection would have allowed us to hand-pick respondents who we knew worked at the intervention worksites, shopped at the intervention food stores, and had children attending the intervention schools. This would have guaranteed a certain degree of exposure to the intervention. However, the intent of the MLMC design was to gain a better understanding of how such interventions can be implemented community-wide and have an impact on the general population, not just those we know for sure will be exposed. Therefore, even though a purposeful sample likely would have led to more significant outcomes, it would not have served the purpose of the study design.

The overall generalizability is limited due to the demographic characteristics of our evaluation sample. Inclusion criteria required that respondents be either the main food shopper or food preparer within their household, and in the OPREVENT communities this role was typically filled by women, as indicated by the predominately female evaluation sample. Therefore, the evaluation sample was not representative of all individuals in the five communities or of the general adult AI population.

There is also some measurement error to be expected when using a QFFQ to assess dietary quality. Food frequency questionnaires are prone to response bias. When used for evaluation of intervention studies, such as in this present analysis, this is especially so as respondents may report what they believe to be socially desirable responses⁵⁵. Additionally, FFQs rely on cognitively complex memory and averaging tasks, resulting in recall bias. Although the OPREVENT QFFQ was relatively short, covering only the past 30 day period, it still required participants to accurately recall portions and frequency of consumption of many food and beverage items. This can lead to systematic error in measurement. There is also the potential for some within person random error, as respondents may report their diets differently at two time periods.

The original OPREVENT study was a community-randomized controlled trial (RCT) among eight AI communities, however this was reduced to five, which. As a result, the trial became more of a pilot-study with a quasi-experimental design as opposed to RCT, and the final evaluation sample was much smaller than the original estimate on which the study was powered. Difference-in-differences analysis was used, but there are limitations to this method. Because we only have one pre-treatment measurement for each individual, we were unable to establish a trend that would confirm the assumption of parallel paths, or the idea that the average change in the comparison group represents the counterfactual for the treatment group. Therefore, it is possible that our DiD estimators are biased.

Finally, dietary intake may be more alike in related individuals or those who share a similar environment, such as members of the same community. This could reduce the between-person variation and reduce the likelihood of observing differences. Clustering at the community level helps to account for this, but it is still possible for variability to be underestimated.

5.6 Conclusion

In summary, we were able to demonstrate that implementation of a MLMC intervention program in five AI communities significantly decreased consumption of regular soda in respondents residing in Immediate Intervention communities. The implications of these findings are far reaching, as SSBs, including regular sodas, contribute significantly to energy intake in indigenous populations worldwide⁵⁷⁻⁶¹. As with AIAN adults, these populations are also disproportionately affected by obesity and type 2 diabetes⁶²⁻⁶⁷, and decreasing consumption of SSBs via MLMC interventions can positively impact risk for these conditions. These findings add to the growing literature of intervention trials seeking to improve dietary intake as a means of addressing obesity in these populations. Future research efforts should continue to work at

multiple levels and within multiple community institutions, and include efforts to increase overall retention and exposure.

5.7 Acknowledgements

We would like to thank all communities participating in OPREVENT and individuals in our evaluation sample. We would also like to thank all food store owners and managers, school administration, staff, and teachers, and business owners for their support, participation in, and contribution to the development and implementation of this program.

Problem Foods	Healthier Promoted Alternatives
<ul style="list-style-type: none"> • Fast food meals • High-fat meats, like pork chops and steak • Processed meats and hotdogs • Pizza • Instant noodles (Ramen, Cup Noodles®) • Fried potatoes and potatoes with added fat (butter, cheese, bacon, sour cream) • High-sugar cereals • Fry bread • White bread • Candy (chocolate, fruit flavored) • Chips, like potato chips and corn chips • Buttered and salted popcorn • Whole milk • Sugar-sweetened beverages, like regular soda, sports drinks, and energy drinks • Alcohol 	<ul style="list-style-type: none"> • Baked, roasted, or boiled chicken • Game meat (venison, elk, buffalo) • Baked potatoes without added fat • Eggs • Low-sugar cereals • High-fiber cereals • 100% whole-wheat bread • Dark leafy green vegetables, like spinach • Other vegetables, like carrots, corn, and green beans (canned, frozen, fresh) • Beans and legumes • Berries • Other fruit, like apples, pears, and oranges (canned, frozen, fresh) • Dry fruit • Baked chips • Light popcorn, puffed rice • Low-fat and fat-free milk • Sugar-free drinks • Water

Figure 5.1: Problem foods and healthier promoted alternatives included on the Semi-quantitative Food Frequency Questionnaire (QFFQ)

Table 5.1: Exposure Scales

Exposure Category	Possible Range	Immediate Intervention (n=118)	Delayed Intervention (n=83)	p-value
1. Logo	0 – 5	3.5 ± 1.0	0.7 ± 1.2	< 0.05
2. Shelf Labels	0 – 20	8.7 ± 6.1	0.5 ± 2.2	--
3. Taste Test & Cooking Demonstration	0 – 27	3.6 ± 2.8	0.2 ± 1.1	< 0.05
4. Poster	1 – 14	7.2 ± 4.2	0.2 ± 0.9	<0.05
5. Educational Display	-2 – 12	2.8 ± 1.6	0.1 ± 0.6	<0.05
6. Flyers	-1 – 20	4.6 ± 3.1	0.1 ± 0.8	<0.05
7. Booklet	0 – 12	4.1 ± 2.4	0.1 ± 0.7	<0.05
8. Giveaway	0 – 14	3.2 ± 2.4	0.1 ± 0.6	<0.05
9. Newsletter	0 – 8	1.9 ± 1.9	0.0 ± 0.2	<0.05
10. Radio	0 – 5	0.6 ± 1.5	0.1 ± 0.7	<0.05
11. School	0 – 17	3.5 ± 6.1	0.2 ± 1.0	<0.05
12. Worksite	0 – 16	4.2 ± 5.6	0.4 ± 1.5	<0.05
Composit scores:				
Food Store ^a	0 – 47	27.3 ± 12.3	0.6 ± 2.6	<0.05
Overall Exposure ^b	-1 – 170	59.3 ± 25.4	3.3 ± 7.8	<0.05

^aSum of categories #2 and #3^bSum of all exposure categories, #1-12

Table 5.2: Median portion sizes at baseline for all food and beverage items included on the Semi-quantitative Food Frequency Questionnaire (QFFQ), by Immediate Intervention (I) and Delayed Intervention (D)

Discouraged Foods & Beverages			Promoted Foods & Beverages			Fruits and Vegetables		
Food	Usual portion size (median (Q1, Q3))		Food	Usual portion size (median (Q1, Q3))		Food	Usual portion size (median (Q1, Q3))	
	I	D		I	D		I	D
Hamburger	4oz (4, 4)	4oz (3.2, 4)	Chicken (baked, roasted, BBQ, boiled)	3oz (1, 6)	3oz (0, 6)	Dark leafy greens	4oz (4, 5)	4oz (4, 8)
Fried chicken	3oz (3, 6)	3oz (0, 6)	Game meat (venison, elk, buffalo)	0oz (0, 6.4)	0oz (0, 2.4)	Other vegetables	8oz (8, 8)	8oz (4, 8)
Meat steaks	8oz (8, 8)	8oz (4, 8)	Fish	0oz (0, 3)	0oz (0, 3)	Green salad	52g (52, 52)	52g (26, 52)
Hot dogs, sausages, & bratwurst	45g (45, 90)	45g (45, 90)	Baked potato, <2 tbsp. added fat	150g (0, 150)	150g (0, 150)	Berries	8oz (0, 8)	8oz (0, 8)
Processed meat slices	1oz (0, 2)	1oz (1, 2)	Eggs	2 eggs (1, 2)	2 eggs (1, 2)	Bananas	1 banana (1, 1)	1 banana (1, 1)
Pizza	98g (75, 150)	75g (75, 150)	Low-sugar cereals	28g (0, 28)	28g (0, 28)	Other fruit	1 fruit (-1, 2)	1 fruit (1, 1)
Ramen	2.3oz (0, 2.3)	2.3oz (0, 2.3)	High-fiber cereals	0g (0, 28)	0g (0, 28)	Dry fruit	0oz (0, 8)	0oz (0, 8)
Fried potatoes	8oz (8, 8)	8oz (6.4, 8)	Hot cereals	41g (0, 41)	41g (0, 41)			
Baked potato, >2 tbsp. added fat (butter, cheese, sour cream)	150g (0, 150)	150g (0, 150)	100% Whole wheat bread (including rye, multigrain, & oat)	25g (25, 50)	25g (25, 50)			

High sugar cereal	14g (0, 28)	14g (0, 28)	Baked chips	0oz (0, 1)	0oz (0, 1)
Fry bread	85g (0, 85)	85g (17, 85)	Popcorn, light butter & salt	0oz (0, 8)	0oz (0, 8)
White bread	25g (0, 50)	25g (5, 50)	Nuts	8oz (0, 8)	4oz (0, 8)
Chocolate candy	2oz (6, 2)	2oz (1, 2)	2% Milk	4oz (0, 16)	8oz (0, 16)
Fruity candy	0oz (0, 0.2)	0oz (0, 0.4)	1% or Skim milk	0oz (0, 5)	0oz (0, 0)
Chips	1oz (1, 1)	1oz (1, 1)	100% Juice	16oz (0, 16)	16oz (8, 16)
Popcorn, with butter & salt	8oz (0, 8)	8oz (0, 16)	Water	5oz (0, 16)	5oz (0, 16)
Whole milk	0oz (0, 16)	0oz (0, 16)			
Regular soda	20oz (12, 20)	20oz (10, 20)			
Sugary drinks	16oz (0, 16)	16oz (0, 16)			
Alcohol	0oz (0, 2)	0oz (0, 0)			

Table 5.3: Daily servings of discouraged foods: baseline, follow-up, and difference-in-differences (DiD) in Immediate Intervention (I) and Delayed Intervention (D) OPREVENT communities

	Baseline			Follow-up			DiD	p-value
	D	I	Difference	D	I	Difference		
Hamburger	0.1 ± 0.1	0.1 ± 0.2	0.0 ± 0.0	0.1 ± 0.1	0.2 ± 0.2	0.0 ± 0.0	-0.0 ± 0.0	0.717
Fried chicken	0.1 ± 0.5	0.2 ± 0.2	0.1 ± 0.0	0.2 ± 0.2	0.2 ± 0.2	0.0 ± 0.0	-0.0 ± 0.0	0.571
Meat steaks	0.2 ± 0.2	0.1 ± 0.2	-0.0 ± 0.0	0.1 ± 0.2	0.1 ± 0.2	0.0 ± 0.0	0.0 ± 0.1	0.434
Hot dogs, sausages, & bratwurst	0.2 ± 0.3	0.2 ± 0.3	-0.0 ± 0.1	0.3 ± 0.7	0.2 ± 0.4	-0.1 ± 0.2	-0.0 ± 0.1	0.762
Processed meat slices	0.2 ± 0.5	0.2 ± 0.5	0.01 ± 0.1	0.2 ± 0.3	0.3 ± 0.5	0.1 ± 0.0*	0.1 ± 0.0	0.199
Pizza	0.2 ± 0.3	0.2 ± 0.3	-0.01 ± 0.1	0.2 ± 0.3	0.2 ± 0.3	-0.0 ± 0.1	-0.01 ± 0.0	0.721
Ramen	0.1 ± 0.3	0.1 ± 0.3	-0.0 ± 0.0	0.1 ± 0.2	0.1 ± 0.3	0.0 ± 0.0	0.0 ± 0.4	0.396
Fried potatoes	0.3 ± 0.4	0.2 ± 0.4	-0.0 ± 0.1	0.2 ± 0.4	0.2 ± 0.5	0.0 ± 0.0	0.1 ± 0.0	0.120
Baked potato, >2 tbsp. added fat (butter, cheese, sour cream)	0.1 ± 0.2	0.1 ± 0.2	0.01 ± 0.0	0.1 ± 0.4	0.1 ± 0.2	-0.0 ± 0.1	-0.0 ± 0.0	0.709
High sugar cereal	0.2 ± 0.4	0.1 ± 0.3	-0.1 ± 0.1	0.2 ± 0.5	0.1 ± 0.3	-0.0 ± 0.1	0.0 ± 0.1	0.722
Fry bread	0.1 ± 0.2	0.1 ± 0.1	-0.0 ± 0.1	0.1 ± 0.2	0.1 ± 0.3	0.1 ± 0.1	0.0 ± 0.0	0.518
White bread	0.5 ± 1.0	0.4 ± 0.8	-0.1 ± 0.3	0.5 ± 1.1	0.3 ± 0.6	-0.2 ± 0.4	-0.1 ± 0.1	0.385
Chocolate candy	0.4 ± 1.0	0.2 ± 0.5	-0.2 ± 0.1	0.2 ± 0.3	0.1 ± 0.2	-0.1 ± 0.1	0.1 ± 0.1	0.181
Fruity candy	2.7 ± 2.2	0.4 ± 1.0	-2.3 ± 2.3	0.4 ± 2.1	0.1 ± 0.5	-0.3 ± 0.31	2.1 ± 2.0	0.371
Chips	0.4 ± 0.9	0.2 ± 0.3	-0.2 ± 0.1	0.2 ± 0.5	0.2 ± 0.4	-0.0 ± 0.1	0.1 ± 0.2	0.577
Popcorn, with butter & salt	0.2 ± 0.7	0.1 ± 0.3	-1.0 ± 0.1	0.1 ± 0.3	0.1 ± 0.4	-0.0 ± 0.1	0.1 ± 0.0	0.486
Whole milk	0.2 ± 0.5	0.1 ± 0.2	-0.1 ± 0.1	0.1 ± 0.3	0.1 ± 0.3	0.0 ± 0.1	0.1 ± 0.0	0.076
Regular soda	0.7 ± 0.9	0.7 ± 1.3	0.1 ± 0.1	0.6 ± 1.1	0.4 ± 0.7	-0.2 ± 0.1	-0.3 ± 0.1	0.038*
Sugary drinks	0.3 ± 0.5	0.2 ± 0.5	0.0 ± 0.0	0.2 ± 0.5	0.3 ± 0.5	0.0 ± 0.1	0.0 ± 0.1	0.981
Alcohol	0.1 ± 0.4	0.2 ± 1.0	0.2 ± 0.2	0.1 ± 0.3	0.2 ± 0.8	0.2 ± 0.2	-0.0 ± 0.0	0.495

*Significantly different between Immediate Intervention and Delayed Intervention communities

Table 5.4: Daily servings of promoted foods: baseline, follow-up, and difference-in-differences (DiD) in Immediate Intervention (I) and Delayed Intervention (D) OPREVENT communities

	Baseline			Follow-up			DiD	p-value
	D	I	Difference	D	I	Difference		
Chicken (baked, roasted, BBQ, boiled)	0.1 ± 0.1	0.2 ± 0.4	0.1 ± 0.1	0.2 ± 0.3	0.3 ± 0.5	0.1 ± 0.1	-0.0 ± 0.0	0.902
Game meat (venison, elk, buffalo)	0.0 ± 0.1	0.0 ± 0.1	0.0 ± 0.0*	0.1 ± 0.1	0.0 ± 0.0	-0.0 ± 0.0	-0.1 ± 0.0	0.002*
Fish	0.0 ± 0.1	0.1 ± 0.1	0.0 ± 0.0	0.1 ± 0.1	0.1 ± 0.3	0.0 ± 0.0	0.0 ± 0.0	0.129
Baked potato, <2 tbsp added fat	0.1 ± 0.2	0.1 ± 0.3	-0.0 ± 0.0	0.1 ± 0.2	0.1 ± 0.2	0.0 ± 0.0	0.0 ± 0.1	0.578
Eggs	0.5 ± 0.7	0.4 ± 0.6	-0.1 ± 0.1	0.52 ± 0.7	0.5 ± 0.7	0.0 ± 0.2	0.1 ± 0.1	0.598
Low-sugar cereals	0.2 ± 0.3	0.1 ± 0.2	-0.1 ± 0.1	0.1 ± 0.2	0.2 ± 0.8	0.1 ± 0.0	0.2 ± 0.1	0.113
High-fiber cereals	0.1 ± 0.1	0.1 ± 0.2	0.0 ± 0.0	0.1 ± 0.10	0.5 ± 5.3	0.4 ± 0.4	0.4 ± 0.4	0.304
Hot cereals	0.1 ± 0.2	0.1 ± 0.2	-0.0 ± 0.0	0.2 ± 0.3	0.2 ± 0.4	0.03 ± 0.8	0.03 ± 0.1	0.607
100% Whole wheat bread (including rye, multigrain, & oat)	0.5 ± 0.9	0.5 ± 0.7	-0.0 ± 0.2	0.5 ± 0.8	0.6 ± 0.8	0.1 ± 0.9	0.1 ± 0.1	0.346
Baked chips	0.1 ± 0.1	0.1 ± 0.1	-0.0 ± 0.0	0.1 ± 0.2	0.1 ± 0.2	0.0 ± 0.0	0.0 ± 0.0	0.665
Popcorn, light butter & salt	0.1 ± 0.2	0.0 ± 0.1	-0.0 ± 0.0	0.0 ± 0.1	0.1 ± 0.1	0.0 ± 0.0	0.0 ± 0.0	0.269
Nuts	0.1 ± 0.3	0.1 ± 0.2	0.0 ± 0.0	0.1 ± 0.2	0.1 ± 0.3	-0.0 ± 0.0	-0.3 ± 0.1	0.509
2% Milk	0.3 ± 0.6	0.2 ± 0.4	-0.1 ± 0.1	0.3 ± 0.5	0.2 ± 0.4	-0.1 ± 0.1	0.0 ± 0.0	0.893
1% or Skim milk	0.1 ± 0.3	0.1 ± 0.3	0.0 ± 0.1	0.1 ± 0.3	0.1 ± 0.3	0.0 ± 0.0	0.02 ± 0.0	0.460
100% Juice	0.3 ± 0.4	0.2 ± 0.4	-0.0 ± 0.1	0.3 ± 0.4	0.2 ± 0.3	-0.1 ± 0.1	0.04 ± 0.0	0.451
Sugar-free drinks	0.6 ± 1.0	0.6 ± 0.9	0.1 ± 0.2	0.5 ± 0.9	0.7 ± 0.8	0.3 ± 0.2	0.2 ± 0.1	0.112
Water	1.6 ± 1.6	2.0 ± 2.4	0.4 ± 0.2	1.7 ± 1.4	1.8 ± 1.6	0.1 ± 0.2	-0.3 ± 0.3	0.331

*Significantly different between Immediate Intervention and Delayed Intervention communities

Table 5.5: Daily servings of fruits and vegetables: baseline, follow-up, and difference-in-differences (DiD) in Immediate Intervention (I) and Delayed Intervention (D) OPREVENT communities

	Baseline			Follow-up			DiD	p-value
	D	I	Difference	D	I	Difference		
Dark leafy greens	0.2 ± 0.5	0.2 ± 0.4	0.0 ± 0.0	0.2 ± 0.3	0.2 ± 0.3	0.0 ± 0.0	-0.0 ± 0.0	0.996
Other vegetables	0.3 ± 0.4	0.4 ± 0.5	0.1 ± 0.1	0.3 ± 0.4	0.4 ± 0.6	0.1 ± 0.1	0.1 ± 0.1	0.529
Green salad	0.1 ± 0.2	0.1 ± 0.2	0.0 ± 0.0	0.1 ± 0.2	0.2 ± 0.3	0.1 ± 0.0	0.0 ± 0.0	0.368
Berries	0.2 ± 0.4	0.2 ± 0.4	0.01 ± 0.1	0.2 ± 0.3	0.3 ± 0.7	0.1 ± 0.0	0.1 ± 0.1	0.394
Bananas	0.3 ± 0.4	0.3 ± 0.6	0.0 ± 0.0	0.3 ± 0.3	0.4 ± 0.5	0.1 ± 0.1	0.1 ± 0.1	0.253
Other fruit	0.4 ± 0.5	0.4 ± 0.6	0.0 ± 0.1	0.4 ± 0.4	0.4 ± 0.8	0.1 ± 0.1	0.1 ± 0.1	0.581
Dry fruit	0.1 ± 0.4	0.1 ± 0.3	0.0 ± 0.0	0.2 ± 0.6	0.1 ± 0.4	-0.1 ± 0.0	-0.1 ± 0.0	0.059

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CHAPTER 6: IMPACT OF OPREVENT ON PSYCHOSOCIAL VARIABLES AND FOOD AND PHYSICAL ACTIVITY RELATED BEHAVIORS

6.1 Abstract

Theory-based behavioral interventions are being implemented in diverse populations to tackle the growing burden of obesity. The Obesity Prevention Research and Evaluation of Intervention Effectiveness in Native North Americans (OPREVENT) project developed based on Social Cognitive Theory (SCT) to address this burden within American Indian (AI) adults. The OPREVENT project took place within food stores, worksites, and schools in five AI communities in Michigan and New Mexico utilizing a multi-level, multi-component (MLMC) design. Intervention content was informed by SCT, and aimed to improve psychosocial factors, including knowledge, self-efficacy, and intentions, as well as food and physical activity (PA) related health behaviors. Difference-in-differences analysis was used to determine whether there were significant differences in each variable from baseline to follow-up within the Immediate Intervention communities (n=3) compared to the Delayed Intervention communities (n=2). Baseline values were also assessed. At baseline, respondents had intermediate levels of self-efficacy and knowledge, and household patterns of food and PA, and low levels of household environment, promoted food-getting frequency, and healthy food preparation. Overall exposure to the intervention was low, and there was no significant intervention impact on any of these variables observed from baseline to follow-up in either intervention group. Results indicated that a large MLMC obesity intervention founded on SCT was not successful in improving psychosocial factors and related food and PA behaviors. Future research should focus on increasing intervention exposure and ensuring that intervention materials and activities specifically target psychosocial variables and related food and PA behaviors.

6.2 Introduction

A recent financial analysis found that just 20 diseases and conditions accounted for more than half of the \$2.1 trillion spent on health care in the U.S. in 2013¹. Type 2 diabetes and ischemic heart disease, both of which are diet-related chronic diseases, together accounted for \$189.5 billion. As healthcare spending continues to increase, researchers are focused on developing effective prevention strategies targeting multiple risk factors, including obesity and related lifestyle behaviors such as dietary intake and physical activity (PA). Theory-based lifestyle interventions, in particular those utilizing Social Cognitive Theory (SCT), are being explored among several populations as an effective and sustainable approach to prevent obesity and its related comorbidities and reduce the burden of disease.

Social Cognitive Theory states that behaviors (e.g. dietary intake, PA), personal determinants (e.g. self-efficacy, knowledge), and environmental factors (e.g. food availability, food cost, access to PA opportunities) exist in triadic reciprocal determinism^{2,3}. Identifying the core set of determinants and the mechanisms through which they work can lead to effective and successful health programs and practices⁴. According to Bandura, the core determinants include; 1) knowledge of health risks and benefits of alternative health practices; 2) self-efficacy of personal control over health habits; 3) outcome expectations of perceived costs and benefits associated with health habits; 4) the health goals, plans, and strategies that people set for themselves; and 5) perceived barriers and facilitators to successful achievement of these goals⁴. The environmental and psychosocial determinants influence behavioral intentions and can predict human behavior⁵.

Knowledge is emphasized in SCT because it is believed that if individuals are unaware of how their lifestyle habits may be detrimental to their health, then they will lack the motivation to change. Knowledge of health risks and benefits associated with lifestyle behaviors sets the stage for change, and may encourage individuals to seek additional information or assistance in modifying their health behaviors. Self-efficacy is considered to be the principal determinant, as individuals must believe that they are able to achieve a desired effect by their actions. It is also

one of the more consistent predictors of health behavior change, especially for diet and PA related behaviors^{6,7}. If self-efficacy is low, then an individual will have little motivation to set behavioral goals and will give up easily when faced with difficulties and perceived barriers. Outcome expectations are also emphasized. Individuals must believe that the beneficial outcomes associated with the new or promoted health behavior exceed the benefits of the current or detrimental health behavior. There are several factors that can influence whether a behavior is associated with improved outcome expectations, including social expectations, personal gains and losses, and whether or not an individual perceives the behavior as being in line with their personal standards, values, and long-term goals⁴. Each of these determinants is integral in the SCT model, and are essential components of successful behavioral interventions. Assessing these variables provides valuable knowledge that can then be used to develop appropriate intervention materials and messages and to support changes in diet and PA. Additionally, observing these values at baseline can provide valuable information to research in regards to community members' readiness to change, their attitudes towards health, whether or not they prioritize health, specifically weight loss, their intentions and desires to change or lose weight, and the current level of health-related knowledge within each community.

The Obesity Prevention Research and Evaluation of InterVention Effectiveness in NaTive North Americans (OPREVENT) was a multi-level, multi-component (MLMC) intervention founded on SCT that was developed to address the obesity burden within American Indian (AI) adults. The Social Ecological Model was also employed, and established the basis for implementing the intervention at multiple environmental levels³.

Implemented in five AI communities from 2012-2013, OPREVENT aimed to change the food-purchasing environment, improve nutritional intake, and increase PA among AI adults via education, promotional activities such as worksite Pedometer Challenges, and partnerships with community organizations to support health opportunities and structural changes. Each of these aims considered the personal determinants and environmental factors that influenced the

promoted behaviors. Research in AI and First Nations populations in particular has shown that interventions targeting certain psychosocial factors such as intentions, health-related knowledge, and self-efficacy, can be effective for healthy dietary and PA related behavioral changes⁸⁻¹¹. Other related behavioral variables include household patterns of food and PA, household environment, healthy food-getting frequency, and food preparation methods^{9,11,12}. However, studies investigating these psychosocial factors and their role in obesity interventions have not taken place amongst the tribal communities participating in the OPREVENT program, which represent unique cultures and environments.

To address this gap in the literature, the OPREVENT program aimed to improve psychosocial and behavioral outcomes, which may then lead to improved food and PA behavioral changes at multiple levels among adult AI in the five participating communities. The objective of this analysis is to report on: 1) the baseline values of psychosocial and health-related behavioral variables; 2) the impact of OPREVENT on these variables; and 2) whether degree of exposure to the intervention was associated with observed changes in these variables among OPREVENT respondents.

6.3 Methods

6.3.1 Study Design and Setting

The OPREVENT program was a community-randomized controlled MLMC obesity intervention pilot-study implemented within five AI communities across Michigan and New Mexico over one year. Components included school, food store, worksite, and media. A detailed description of the intervention can be found in **Chapter 4**. The program was designed to improve dietary intake and increase physical activity, and emphasized changes in distal modifiable behavioral outcomes including psychosocial factors such as health-related knowledge, self-efficacy, and intentions. The OPREVENT materials, promotional activities, and educational

sessions reflected this aim. General food and PA knowledge was provided throughout, ranging from in-depth booklets (e.g. What is Fat, What is Fiber) to quick PA and nutrition facts listed on posters (e.g. adults should aim for 150 minutes PA per week, what counts as a cup of fruit). Improvements in self-efficacy were promoted via goal setting, social modeling, and verbal persuasion through support from friends and family.

6.3.2 Study Population, Recruitment, and Randomization

Data for this study were collected in five American Indian communities, representing four different tribes, across Michigan and New Mexico. The three New Mexican communities and two Michigan communities were similarly rural or semi-rural. Eligibility criteria for communities included: an on-reservation population of at least 500, an on-reservation school, at least one on-reservation food store (grocery store, supermarket, or convenience store), and at least one worksite with no less than five tribal member employees. Access to PA facilities varied across the communities. More rural reservations typically had only their own tribal-owned and operated fitness centers, while residents on reservations with greater proximity to larger non-tribal communities were able to benefit from commercial fitness centers.

Communities were stratified by location, relative isolation, local resources, and language group, and then randomized to Immediate Intervention or Delayed Intervention groups. Households in each community were randomly selected from tribal lists. Within each household, one adult between the ages of 18 – 65 years old who had been living in the house for at least the past 30 days was randomly selected. Other inclusion criteria included: tribal member and either the main food shopper or the main food preparer for the household. Exclusion criteria included: currently pregnant or breastfeeding women. If the adult was eligible but declined to participate, enrollment continued with the next household on the list. The aim was to enroll 85 adults randomly selected at baseline from each community, resulting in a total $n = 424$. This resulted in

alpha = 0.05 and power = 80% to detect change in percent time engaged in sedentary activity (sitting).

Three communities were randomized to Immediate Intervention and two communities were randomized to Delayed Intervention. Baseline data were collected in the spring of 2012 and the intervention was implemented in the Immediate Intervention communities from the summer of 2012 to the summer of 2013. Follow-up data were collected 24 – 27 months later, in the fall of 2013 and spring of 2014, after which the intervention was implemented in Delayed Intervention communities.

Data collectors were trained by Johns Hopkins School of Public Health (JHSPH) and included tribal community members fluent in the Native language and JHSPH graduate students. Data collection training consisted of several in-person sessions as well as in-service trainings throughout the project to maintain quality of data. Interviews took place in community buildings as well as private homes, depending on the respondents' preferences. The Navajo Nation Human Research Review Board (NNHRRB), Indian Health Service (IHS) Institutional Review Board (IRB), the JHSPH IRB, and individual participating tribal councils approved the study. Signed consent was obtained from all respondents.

6.3.3 Data Collection and Instruments

Data Collection. Data was collected via in-person interviews conducted by trained data collectors. Baseline data collection occurred during the summer of 2011, and follow-up data collection occurred in fall 2013 and spring 2014. Consent to participate was obtained from all respondents prior to each interview. Each interview took between 90 – 120 minutes to complete, after which respondents received \$40 gift cards to Wal-Mart in appreciation for their participation.

Instruments. The present study reports results from specific sections of the Adult Impact Questionnaire (AIQ) and the Intervention Exposure Evaluation (IEE). The AIQ was completed at both baseline and follow-up, while the IEE was completed only at follow-up. The AIQ consisted of 15 sections, three of which are the focus of the present analysis: healthy intentions, self-efficacy, and food and health knowledge. Data and results from other sections are presented in **Appendix A**. The AIQ also collected demographic information, including age, sex, household size, marital status, educational level, employment status, current smoking status, personal and family history of chronic disease, and food-assistance program participation.

The IEE consisted of 11 sections that measured the type and amount of exposure to the intervention components, including: 1) OPREVENT Logo; 2) Shelf Labels; 3) Taste Tests; 4) Posters and Educational Displays; 5) Flyers and Booklets; 6) Store Visits; 7) Giveaways; 8) OPREVENT Newsletter; 9) Radio Announcements; 10) OPREVENT School Activities; and 11) OPREVENT Worksite Activities. The following instructions were read by the interviewer to the respondent: “We would like to ask you if you have seen materials related to the OPREVENT program. Our main goal is to hear about your experiences and your opinions. There are no right or wrong answers. We are (I am) only here to gather information. I am now going to ask you about or show you some pictures of materials or activities that might have been part of the OPREVENT program in your community.” Responses categories were ‘Yes,’ ‘No,’ or ‘Not Applicable: did not recognize any materials.’ However, the Not Applicable option was not read aloud and was used only as a last resort if probing attempts had failed.

6.3.4 Data Management

Copies of all data collection instruments were sent to the project’s Data Manager at JHSPH in Baltimore, Maryland where they were entered into Microsoft Access databases and Microsoft Excel spreadsheets (Microsoft Corporation). All data were then exported to Stata

software, version 12.1 (StataCorp) for analysis. Outliers were identified using the Tukey Method and removed if they were deemed to be influential.

6.4 Analysis

6.4.1 Descriptive Analyses

Descriptive analyses comparing baseline characteristics of the Immediate Intervention and Delayed Intervention communities were conducted using *t*-tests for normally distributed continuous variables, non-parametric Wilcoxon-Mann-Whitney tests for non-normal continuous variables, and chi-square tests for dichotomous variables. A 21-item Material Style of Life (MSL) scale was used to approximate socioeconomic status (see Gittelsohn et al, 2006⁹ for details). Respondents were asked whether they owned each household item (e.g. TV, automobile, refrigerator) in working condition.

6.4.2 Scale Construction

A series of scales were developed to assess the psychosocial determinants addressed in the OPREVENT intervention. Internal consistency of each scale was evaluated using Cronbach's alpha ¹³.

Intentions. The AIQ contained nine questions on intentions, meant to represent the core determinant of health goals, plans, and strategies of SCT. Interviewers read the following instructions to the respondents: "Next, I am going to ask you questions about some of your food and physical activity habits. If you are given only three choices to pick from, which one would you really choose? Go with your best answer." For each question, there was one choice promoted by the OPREVENT intervention deemed to represent positive intentions to act in such a way that is favorable to health ("correct"), and two that were discouraged and deemed to represent no intention to act in such a way that is favorable to health ("incorrect"). Correct responses were

scored as 1, and incorrect responses were scored as 0. Overall final scores were calculated by summing the responses and taking the mean.

Internal consistency of the Intentions scale was assessed using Cronbach's alpha. Analysis gave a Cronbach's alpha of 0.5, which is much lower than previously determined in similar studies^{9,11,12,14}, and indicates low internal consistency¹⁵. An exploratory factor analysis was conducted and found that there were four components with eigenvalues greater than one, suggesting that the intentions scale may have been measuring four underlying constructs and not intentions alone. Because of this, the Intentions scale was dropped from analysis and two questions from the scale related to previously reported findings from the OPREVENT study were analyzed independently: 1) choose water instead of regular soda or 100% juice; and 2) go for a walk instead of take a nap or watch TV/use the computer. These two questions were chosen specifically because they are most related to changes in PA and dietary intake, the primary outcomes for OPREVENT.

Self-efficacy. The AIQ contained 14 questions on Self-efficacy. Interviewers read the following instructions to the respondents: "Now I'm going to ask you about some activities. I'd like you to tell me how DIFFICULT or EASY it would be for you to do them in your everyday life now, given how much free time you have, what your family likes to eat, or what may be affordable. If you are unsure, go with your best answer. Remember, I only want to know how difficult or easy these activities would be for you if you had the choice right now." Correct answers received a score of 1 and incorrect answers received a score of 0. The overall self-efficacy scores were calculated for each group by summing the number of correct answers for a possible total of 14 points and calculating the mean. Internal consistency of the Self-efficacy scale was assessed with Cronbach's alpha, and was determined to be 0.7.

Knowledge. The AIQ contained ten questions on health-related Knowledge. Interviewers read the following instructions to the respondents: "Now, I am going to ask you about some of your current food or physical activity choices. If you were given three choices to pick from,

which one would you choose? Pick the answer you would really choose.” For each question, there was one correct answer and two incorrect answers. Three of the questions were based on a food label, which the interviewer showed to the respondent. Correct and incorrect responses were scored as 1 and 0, respectively. The overall Knowledge scores were calculated for each group by summing the number of correct answers for a possible total of ten points and calculating the mean, with a Cronbach’s alpha of 0.7.

Household Patterns of Food and Physical Activity. There were five questions related to overall patterns of food and PA habits within respondents’ households included on the Household Patterns of Food and Physical Activity (HPFPA) scale (e.g. “In the last 30 days, how often did people in your home eat a meal together, like dinner?”). Interviewers read “Now I will ask you about food and physical activity habits in your household in the last 30 days. After I read the activity, please tell me whether you do it ‘NEVER,’ ‘HARDLY EVER,’ ‘SOME OF THE TIME’, or ‘MOST OF THE TIME.’ Go with your best answer.” Responses to four of the questions were assigned values as follows: never = 0; hardly ever = 1; some of the time = 2; and most of the time = 3. Responses to one question were reverse scored, as the question asked about a non-health promoting behavior (question #3, **Table 6.7**). Overall scores were calculated by summing the point values and calculating the mean, with a Cronbach’s alpha of 0.6.

Household Environment Scale. The Household Environment scale consisted of eight questions that assessed the household environment in terms of family member responsibilities, time spent together, and importance of health and wellness (e.g. “In your household, how often is it hard finding time to spend together on weekdays?”). The following instructions were read to the respondents: “Next, I am going to ask you to describe life at home. Think about the people in your household and whether you think this is true ‘NEVER,’ ‘HARDLY EVER,’ ‘SOME OF THE TIME’, or ‘MOST OF THE TIME’ in your household. Remember that this is not a test. There are no right answers to these questions. We just want to know what you think about how people interact with each other in your home.” Each response was assigned a point value ranging

from 0-3, with 0 assigned to “Never” and 3 assigned to “most of the time.” Responses were summed and averaged for the final scores, with a Cronbach’s alpha of 0.6.

Health Attitude Scale. The AIQ contained an eight-question scale measuring general attitude towards health and healthy lifestyle behaviors, serving as a proxy for the outcome expectations determinant in SCT. Interviewers read, “I am going to read you some statements. Please tell me whether you generally DISAGREE or AGREE with each statement. Go with your best answer.” Responses of “agree” received a score of 1, and responses of “disagree” received a score of 0. Responses were summed and average to obtain the final scores, with a Cronbach’s alpha of 0.5. Because of this low internal consistency, a factor analysis was performed and revealed up to three underlying constructs. Therefore, the Health Attitude scale was excluded from analysis, and two questions related to previous findings from the OPREVENT intervention were extracted from the scale to be assessed independently: 1) respondent would exercise if he/she had time; and 2) physical activity facilities are not available where respondent lives. These two questions were chosen specifically because they are most related to changes in PA.

Promoted Food-getting Frequency. The AIQ contained 22 questions on Promoted Food-getting Frequency (PFGF). The 22 items included all foods and beverages that were promoted throughout the OPREVENT intervention. Interviewers read the following instructions to respondents: “Now, I will start by asking you about foods that you may have BROUGHT into your home for yourself and other household members. Think about foods you may have BOUGHT in stores, GOTTEN food from a food bank, GOTTEN from hunting or fishing, GOTTEN as a gift from someone, or BROUGHT into the house as meals. For each food listed here, please tell me the number of times you GOT each food in the last 30 DAYS [from ____ to yesterday]. Your answer choices are: 0 or Never, 1-5 times, 6-10 times, 11-15 times, or more than 15 times. Do not include already prepared foods from vendors, delis or restaurants. There are no right or wrong answers, so go with your best answer.” Each response category was assigned at point value ranging from 0-4, with the lowest value being assigned to the “0 or never” category

and the highest value being assigned to the “>15 times” category, for a total possible point value of 88. The PFGF scores were calculated for each group by summing the point values and taking the mean, with a Cronbach’s alpha of 0.9.

Healthy Food Preparation. The Healthy Food Preparation scale was comprised of six questions that evaluated the healthfulness of cooking methods commonly used by respondents. Interviewers read, “Now I am going to ask you about how you have cooked different food items at home in the last 30 days. Please tell me your first and second cooking method of choice for each food item. For example, you can say your most common method of cooking for a potato may be ‘deep fry in lard’ and your second method is ‘bake with vegetable oil.’” Foods included on the scale included ground beef, chicken, pork, fish, potatoes, and vegetables. Thirteen cooking methods were assigned a score between -1 and 2, with higher scores indicating more healthful cooking methods (e.g. no added fat). Scores were as follows: deep-fried in oil, lard, or shortening: -1; pan-fried in oil, lard, or shortening: -1; microwaved, baked, broiled with added fat: -1; boiled or crockpot: 0; pan-fried in own fat or water: 0; steamed: 0; smoked: 0; cooked with cooking spray only: 0; grilled: 0; microwaved, baked, or broiled without added fat: 0; pan-fried in own fat or water and drained: +1; pan fried in own fat, drained, and rinsed: +2; and boiled and drained or skimmed: +2. Respondents’ primary cooking methods were weighted by a factor of 0.6, and secondary cooking methods were weighted by a factor of 0.4. Final scores were summed and averaged, with a Cronbach’s alpha 0.6.

Exposure. The IEE was scored and used to create an overall exposure scale using the same protocol as used in similar studies conducted by the PI^{12,16,17}. All ‘Yes’ and ‘no’ exposure responses were coded to zeros and ones, and missing responses were coded as zeros. Weights were assigned to individual questions and entire categories based on whether they were categorized as passive, low active, or high active level of engagement. Any positive answers to red herring questions were reverse scored. The scored responses from the following categories were summed to create an overall exposure scale: logo score, shelf label score, taste test/cooking

demo score, poster score, educational display score, flyer/pamphlet score, booklet score, promotional item score, newsletter score, radio announcement score, worksite score, and school score. Overall exposure was further categorized into quartiles, and differences in outcomes based on exposure levels were assessed using linear regression.

6.4.3 Impact Analysis

Impact analyses was conducted using a quasi-experimental approach to compensate for the fact that only five of the original eight communities completed the OPREVENT study and it is unlikely that randomization was achieved. Therefore, the difference-in-differences (DiD) method was used to evaluate the impact of OPREVENT on psychosocial and behavioral outcomes. Sub-analyses were then performed to determine whether the changes in psychosocial and behavioral outcomes differed by overall exposure. Alphas were set to 0.05

6.5 Results

Demographics. Data were collected on a total of 424 respondents, of which 299 completed both baseline and follow-up data collection. Only respondents with both baseline and follow-up surveys were included in the evaluation sample. Select demographic information for the evaluation sample is presented in **Table 6.1**. A complete summary of demographic information is given in **Chapter 4, Table 4.1**.

On average, the evaluation sample was 44.5 years of age and predominantly female (71.3%). Approximately 45.8% of respondents reported that a medical professional had ever told them that they were obese, which is consistent with the CDC's recent estimate of 42.3% in AIAN adults aged 18 years and older¹⁸. Our BMI measurements estimated a slightly higher obesity prevalence of 53.4%. Approximately 49.8% of respondents reported participation in the Supplemental Nutrition Assistance Program (SNAP), which is an estimate much greater than that

estimated in the general AI population (24%)^{19,20}. Despite randomization, several variables were significantly different between the Immediate Intervention and Delayed Intervention groups at baseline, including: having a tech school degree, household size, current smoking status, and participation in WIC, SNAP, commodity foods, senior center food distribution, and food bank.

6.5.1 Exposure

Exposure to the intervention was low (**Table 6.2**). Communities randomized to Immediate Intervention had significantly greater exposure than communities randomized to Delayed Intervention. The highest exposures were reported for shelf-labels (8.7 out of 20) and posters (7.2 out of 14), while the lowest exposures was reported for newsletters (1.9 out of 8) and radio announcements (0.6 out of 5).

6.5.2 Patterns of psychosocial and behavioral outcomes at baseline

Because they are the core determinants of SCT, the results for the Self-efficacy, Knowledge, and two Intentions questions retained from the original scale are reported here. Results for all other scales are reported in **Appendix A**. Overall, respondents demonstrated intermediate levels of Self-efficacy and Knowledge (mean \pm SD scores of 8.7 ± 2.4 and 7.7 ± 1.9 , respectively) (**Table 6.3**). Respondents scored intermediate to high on the two Intentions questions (**Table 6.4**).

Intentions. Baseline responses to the two questions retained from the original Intentions scale are shown in **Table 6.4**. In general, a majority of the evaluation sample (72.4%) had healthy intentions when it came to choosing a healthy drink next time they were thirsty (water instead of regular soda or 100% juice). Approximately half of the evaluation sample had healthy intentions to walk instead of nap or watch TV/use the computer next time they had free time (49.2%).

Self-efficacy. **Table 6.5** summarizes the Self-efficacy scale at baseline. More than 50% of respondents replied “easy” to all 12 questions, with “steam, boil, or bake potatoes instead of frying them” and “use cooking spray or vegetable oils instead of lard” receiving the greatest percent of “easy” responses. Questions with the smallest percentage of “easy” responses included using food labels to make food choices, ordering a salad instead of French fries at a restaurant, and choosing low-fat or skim milk instead of whole milk.

Knowledge. Baseline Knowledge score can be found in **Table 6.6**. Overall, respondents had intermediate food-related knowledge at baseline. Scores ranged from 1-10 out of a possible 10, and the overall average score was 7.7 ± 1.9 . Most of the respondents answered correctly to all ten knowledge questions. Respondents were less knowledgeable about identifying the drink with the fewest calories, the cooking method that added the least amount of fat, the recommended time that adults should be active each day, and using a food label to identify the amount of fat in an entire package.

6.5.3 Intervention Effects

Difference in differences analyses of the psychosocial and behavioral variables found no intervention effect comparing the Immediate Intervention group and the Delayed Intervention group from baseline to follow-up (**Table 6.12**). Change in psychosocial and behavioral variables did not differ significantly by overall exposure to intervention.

6.6 Discussion

We found that overall, respondents had intermediate levels of self-efficacy and knowledge at baseline, and intermediate to high scores for healthy intentions at baseline. There was no significant intervention effect for any of these outcomes observed from baseline to follow-up when comparing Immediate and Delayed Intervention groups. An in-depth discussion of the

Self-efficacy, Knowledge, and Intentions results is reported here. Discussion regarding all other scales is given in **Appendix A**.

At baseline, respondents had overall low self-efficacy for using food labels to choose foods, ordering a salad instead of French fries at a restaurant, and choosing low-fat or skim milk instead of whole. Self-efficacy was generally high for the other nine behaviors included in the scale. There was no significant change in overall self-efficacy from baseline to follow-up in either Delayed or Immediate Intervention communities.

Respondents demonstrated intermediate health-related knowledge at baseline. There were no significant DiD estimates from baseline to follow-up comparing the Immediate and Delayed Intervention communities. According to SCT, knowledge of health risks and benefits establishes the precondition for change⁴. The intermediate knowledge demonstrated here, and the absence of significant change in knowledge from baseline to follow-up, suggest that respondents may not have had sufficient knowledge to motivate behavior change.

These findings for self-efficacy and knowledge are comparable to other similar studies conducted in Native populations. The two food store-based obesity interventions, Apache Healthy Stores (AHS) that took place on the White Mountain and San Carlos Apache reservations in Arizona and Navajo Healthy Stores (NHS) that took place within the Navajo Nation, both found moderate healthy food knowledge and high self-efficacy pre-intervention^{9,12}. A MLMC obesity prevention study in a First Nations Inuit population, called Healthy Foods North (HFN), found that respondents demonstrated moderate healthy food knowledge and high healthy food self-efficacy^{11,21}. All three studies employed the same data collection methods and similar scale creation processes to estimate these scores, with only slight variations in question content based on formative work in the differing study communities.

Baseline healthy intentions were fairly high for the question “If you were thirsty, which would you choose for a drink?”. Given the options of regular soda, 100% juice, or water, 72.4% of the evaluation sample chose water. Analyses did show an increase in this outcome from

baseline to follow-up, however it was not significant in either Delayed or Immediate Intervention groups. Baseline healthy intentions were intermediate for the question, “The next time you have free time at home, what will you do?” as only 49.2% indicated that they would take a walk instead of watch TV/use the computer or take a nap. Difference-in-differences analysis did not show any significant change from baseline to follow-up for this outcome. These findings appear to be in line with low self-efficacy and knowledge related to PA, as well as baseline intentions scores from the AHS, NHS, and HFN programs, all of which found moderate levels of intention to perform healthy dietary behaviors^{9,11,12,21}.

Based on this analysis, we can determine that community members were actively thinking about their health-related decisions, they had moderate to high health and food-related knowledge, and they felt fairly confident that they could perform specific health-related behaviors in their lives. This baseline analysis indicates a readiness to change and a relatively supportive environment in which to implement an intervention. However, it could also mean that community members were already engaged in many health-related behaviors, and that intervention materials should specifically target the areas in which respondents’ answers were weakest.

6.7 Limitations

There are several possible explanations for why there were no improvements observed in self-efficacy from baseline to follow-up. An individual’s self-efficacy and the degree to which it impacts their ability and motivation to achieve a behavior change is largely dependent upon whether they believe themselves to have an independent or interdependent self-construal. Those with an independent self-construal will be driven to discover and express his or her unique attributes and abilities, and seek to stand out in the social environment²², and therefore may be more receptive to community-wide intervention messages and activities promoting self-efficacy. Individuals with an interdependent self-construal see their behaviors as determined and

contingent on other members of the larger social group to which they are connected²². In this scenario, attempts to influence self-efficacy may prove to be futile if the desired behaviors are not socially oriented goals^{22,23}. American Indian, and particularly Navajo, cultures demonstrating higher collectivism have been shown to display interdependent self-construals in certain contexts²⁴⁻²⁶. It is possible that the AI adults participating in the OPREVENT intervention also demonstrated interdependent self-construals, and that at the time of the program, changes in self-efficacy for diet and PA related behaviors were not considered to be relevant to the functioning of the larger group, or were seen as something that would set individuals apart and disrupt group harmony, rather than lead to greater connectedness.

Additionally, there are very specific approaches for developing self-efficacy, including mastery experience, social modeling, improving physical and emotional states, and verbal persuasion²⁷. It is possible that although the OPREVENT intervention was not targeted, the activities and messages that encouraged and promoted self-efficacy using these strategies could have been better achieved in the passive, non-targeted setting.

Mastery experience refers to the idea that as individuals experience successes, their belief that they can achieve an outcome and overcome barriers becomes stronger²⁷. One way to encourage this is through goal-setting and journaling about successes. While OPREVENT did include information about goal setting on intervention materials, there were no formal instructions or activities to help community members set and stick to their health goals.

Social modeling can be used to boost self-efficacy and generate positive outcome expectations, as individuals will feel more confident in their ability to perform a behavior if they see that someone like them and with similar capacities has succeeded^{27,28}. This was attempted in OPREVENT, as all intervention materials depicted individuals from the five communities choosing healthy foods, exercising, or performing other promoted activities. However, it is possible that using actual community members as opposed to an anonymous adult of AI ethnicity backfired, as there is anecdotal evidence from conversations with respondents that they knew the

community members personally, and knew that “she doesn’t exercise” or “he doesn’t drink low-fat milk.” Therefore, the social modeling was unsuccessful as a motivator.

Improvement of physical and emotional states related to the behavior will also support improved self-efficacy²⁷. Physical and emotional states will vary based on the levels of stress and anxiety in an individual’s surroundings, as well as whether their environment is positive and supportive. This was also attempted in OPREVENT. Working with food stores, schools, and worksites endeavored to create resources and a positive environment that would support community members in their health goals from all perspectives. Intervention materials also included messages such as planning meals and workouts ahead to avoid unhealthy decisions influenced by stress or lack of time, or exercising with a friend to foster support and accountability. However, as with goal setting, these messages were only displayed on materials and were not actually incorporated into OPREVENT activities or emphasized in formal instruction.

Finally, verbal persuasion can also be used to develop self-efficacy. Verbal persuasion refers to the idea that when individuals receive support, positive feedback, encouragement, or compliments and congratulatory remarks from others within their social network, they will feel more confident in their abilities and self-efficacy for a behavior will improve. This was promoted in OPREVENT through intervention messages promoting group activities such as going on a walk with a friend, preparing a healthy meal as a family, participating in the worksite Pedometer Challenges, and encouraging children to act as change agents to share health information with the adults in their lives and encourage healthy family activities. This strategy may have had the most potential within our AI population, as the tendency for interdependent self-construal would suggest that verbal persuasion from several different points within the environment would encourage an individual to pursue the desired behavior in an attempt to fit in or do what is perceived to be best for and accepted by the community. However, as Bandura points out in his description of this strategy, verbal persuasion without arrangement of conditions to facilitate the

behavior will lead to failure that discredits the persuaders and undermines the recipient's self-efficacy²⁷. It is possible that the facilitators necessary to carry out the OPREVENT promoted behaviors were insufficient.

Five of the scales used in the analysis had Cronbach's alphas below 0.7, which is generally considered to be questionable and indicates low reliability¹⁵. The scales were not pilot-tested in the communities prior to data collection, and therefore it is possible that they do not truly reflect the constructs they are intended to measure. The behavioral variables are also limited in interpretability. The promoted food-getting frequency scale categorized respondents according to the frequency with which they got the OPREVENT promoted food and beverage items in the last 30 days, but did not capture any information regarding actual dietary intake. Similarly, the food preparation scale can only provide information on preferred cooking methods. These scales cannot make any assumptions about actual consumption, portion size, or other factors affecting diet quality.

The Self-efficacy scale used in the present study is not identical to that used in the previous work. In the present scale, respondents were asked whether it would be difficult or easy to do a certain activity in their everyday life. This dichotomized response is quite different than the Likert-type scale that has been used in the existing literature. Formative work prior to the OPREVENT study found that a Likert-type scale was unacceptable for use in this population, primarily because the participating AI cultures did not differentiate between degrees such as "somewhat difficult" or "very difficult." Therefore, the dichotomous responses were used. However, the internal consistency of the Self-efficacy scale used in the present study is slightly lower than what has been reported in the literature^{9,11,12,14}.

Additionally, there is the opportunity for increased integration of SCT within a larger ecological context. The Social Ecological Model provided the basis of the OPREVENT intervention implementation, and provided guidelines for development of each intervention component (food store, worksite, school, and media). However, intervention messages and

activities delivered within each component were developed based on tenets of SCT that function at the individual level, and more could have been done to promote environmental and policy changes. Researchers and health organizations such as the World Health Organization, the Institute of Medicine, and the Centers for Disease Control and Prevention have identified environmental and policy interventions as the most promising approach for generating population-wide improvements in nutrition, PA, and weight status²⁹⁻³⁴, as well as obesity control³⁵⁻³⁷. Psychosocial models such as SCT can be better integrated into ecological frameworks to maximize intervention effectiveness and provide specific aims and hypotheses³.

Finally, data were collected only on individuals identifying as the primary food shopper and/or preparer of their household. In the five OPREVENT communities, this individual was typically female, and therefore our evaluation sample is not representative of all AI adults within the communities or of the AI adult population in general.

6.7 Conclusion

Interventions based on behavioral theories are being implemented widely among various cultures to promote health behavior change related to obesity. Diet-related diseases such as obesity and type 2 diabetes are prevalent within AIAN populations at an alarming degree, and Native communities are motivated to improve the health and wellness of their people. The OPREVENT program used SCT to design and implement a MLMC adult obesity prevention program in five communities that aimed to improve psychosocial and behavioral mediators of diet and PA that are central to SCT, such as intentions, knowledge, and self-efficacy. This was the first study to examine changes in these health outcomes through use of an MLMC approach within AIAN communities. There was no observed intervention impact on psychosocial determinants from baseline to follow-up in either intervention group. Future research should

focus on increasing exposure to the intervention, as well as using well-established strategies for developing key behavioral determinants within a larger ecological framework.

6.8 Acknowledgements

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Table 6.1: Sociodemographic characteristics of the OPREVENT evaluation sample at baseline (n=299)

Characteristics	Immediate Intervention (n=182)	Delayed Intervention (n=117)
Female (%)	69.6	72.7
Age (y)	45.2 ± 14.0	43.3 ± 12.6
Education (%)		
High school	22.9	29.1
Tech School	8.9	2.6*
Some college	33.0	16.2*
College	2.2	2.6
Graduate School	0.0	0.0
History of disease (%)		
Obesity	47.2	41.1
Heart disease	8.5	8.8
High blood pressure	32.4	30.7
Type 2 diabetes	20.5	25.4
Participation in SNAP ^a	43.1	61.2*
MSL ^b	12.8 ± 4.5	13.8 ± 5.0
BMI ^c (kg/m ²)	32.3 ± 7.7	32.0 ± 8.1
Overweight (%)	28.9	29.1
Obese (%)	57.2	52.1

*Significantly different from Immediate Intervention group at baseline

^aSupplemental Nutrition Assistance Program

^bMaterial Style of Life (scale used as proxy for socioeconomic status)

^cBody Mass Index

Table 6.2: Exposure Scales

Exposure Category	Possible Range	Immediate Intervention (n=118)	Delayed Intervention (n=83)	p-value
1. Logo	0 – 5	3.5 ± 1.0	0.7 ± 1.2	< 0.05
2. Shelf Labels	0 – 20	8.7 ± 6.1	0.5 ± 2.2	--
3. Taste Test & Cooking Demonstration	0 – 27	3.6 ± 2.8	0.2 ± 1.1	< 0.05
4. Poster	1 – 14	7.2 ± 4.2	0.2 ± 0.9	<0.05
5. Educational Display	-2 – 12	2.8 ± 1.6	0.1 ± 0.6	<0.05
6. Flyers	-1 – 20	4.6 ± 3.1	0.1 ± 0.8	<0.05
7. Booklet	0 – 12	4.1 ± 2.4	0.1 ± 0.7	<0.05
8. Giveaway	0 – 14	3.2 ± 2.4	0.1 ± 0.6	<0.05
9. Newsletter	0 – 8	1.9 ± 1.9	0.0 ± 0.2	<0.05
10. Radio	0 – 5	0.6 ± 1.5	0.1 ± 0.7	<0.05
11. School	0 – 17	3.5 ± 6.1	0.2 ± 1.0	<0.05
12. Worksite	0 – 16	4.2 ± 5.6	0.4 ± 1.5	<0.05
Composite scores:				
Food Store ^a	0 – 47	27.3 ± 12.3	0.6 ± 2.6	<0.05
Overall Exposure ^b	-1 – 170	59.3 ± 25.4	3.3 ± 7.8	<0.05

^aSum of categories #2 and #3^bSum of all exposure categories, #1-12

Table 6.3: Psychosocial and food and physical activity related behavioral outcome scores at baseline in the OPREVENT evaluation sample

Domain	Possible Range	Actual Range	Score	Cronbach's alpha
Adult self-efficacy	0 – 14	0 – 12	8.7 ± 2.4	0.7
Knowledge	0 – 10	1 – 10	7.7 ± 1.9	0.7
Household Patterns of Food and Physical Activity	0 – 15	3 – 15	9.5 ± 2.4	0.6
Household Environment	0 – 24	4 – 21	12.9 ± 3.5	0.6
Promoted Food-getting Frequency	0 – 88	4 – 69	19.2 ± 8.7	0.9
Healthy food Preparation	-12 – 24	-4 – 17	5.7 ± 4.3	0.6

Table 6.4: Intentions at baseline in the OPREVENT evaluation sample

Question	Correct (%)
1. If you were thirsty, which would you choose for a drink? (regular soda, 100% juice, or water)	72.4
2. The next time you have free time at home, what will you do? (take a nap, go for a walk, watch TV or use the computer)	49.2

Table 6.5: Self-efficacy at baseline in the OPREVENT evaluation sample

Question: Would it be difficult or easy for you to...	Easy (%)
1. Choose water instead of regular soda?	81.9
2. Use cooking spray or vegetable oils instead of lard?	85.2
3. Use food label information to make your food choices?	55.9
4. Choose low-fat or fat-free milk instead of whole or 2% milk?	62.1
5. Rinse ground meat in hot water after cooking and draining it?	69.3
6. Eat smaller portion sizes instead of larger portion sizes?	70.3
7. Steam, boil, or bake potatoes instead of deep-frying them?	88.6
8. Buy 100% whole wheat bread instead of white bread?	77.9
9. Eat more low sugar and higher fiber cereals?	76.2
10. Order a salad instead of French fries at a fast food restaurant?	61.6
11. Walk for 30 minutes most days of the week?	64.7
12. Buy leaner cuts of red meats?	74.1
Average self-efficacy score (mean \pm SD)	8.7 \pm 2.4

Table 6.6: Knowledge at baseline in the OPREVENT evaluation sample

Question	Correct (%)
1. Which of the following foods is lowest in fat?	81.1
2. Which kind of bread has the most fiber?	85.9
3. Which of the following adds less fat when you use it to cook with?	67.3
4. Which of the following drinks has fewest calories?	53.4
5. Which cereal has more fiber?	80.6
6. What is the biggest dietary risk factor for developing Type 2 Diabetes?	88.5
7. How many grams of sugar are in ONE SERVING SIZE in this food label?	87.2
8. What is the serving size of the food item in this food label?	84.5
9. What is the total fat content in this entire package?	68.7
10. What is the recommended amount of time adults should spend doing moderate physical activity each day?	66.0
Average knowledge score (mean \pm SD)	7.7 \pm 1.9

Table 6.7: Psychosocial and behavioral changes: baseline, follow-up, and difference-in-differences (DiD) in OPREVENT Delayed Intervention (D) and Immediate Intervention (I) communities

Scale	Baseline (mean \pm SD)			Follow-up (mean \pm SD)			DiD (mean \pm SD)	p-value
	D	I	Difference	D	I	Difference		
Self-efficacy	3.5 \pm 2.6	4.1 \pm 2.5	0.1 \pm 0.1	4.6 \pm 2.7	4.8 \pm 2.5	0.1 \pm 0.1	0.0 \pm 0.0	0.654
Choose water instead of regular soda or 100% juice (intentions)	3.5 \pm 2.6	4.1 \pm 2.5	0.1 \pm 0.1	4.6 \pm 2.7	4.8 \pm 2.5	0.1 \pm 0.1	0.0 \pm 0.0	0.654
Go for a walk instead of take a nap or watch TV/use the computer (intentions)	3.7 \pm 2.5	3.6 \pm 2.3	0.0 \pm 0.3	4.3 \pm 2.5	4.5 \pm 2.5	0.1 \pm 0.3	0.1 \pm 0.1	0.425
Knowledge	3.7 \pm 2.5	3.6 \pm 2.3	0.0 \pm 0.3	4.3 \pm 2.5	4.5 \pm 2.5	0.1 \pm 0.3	0.1 \pm 0.1	0.425
Household patterns of food and physical activity	9.5 \pm 2.5	9.6 \pm 2.4	0.1 \pm 0.5	8.8 \pm 2.5	9.6 \pm 2.3	0.8 \pm 0.4	0.7 \pm 0.4	0.124
Household environment	13.0 \pm 3.6	12.8 \pm 3.4	-0.2 \pm 0.9	12.8 \pm 3.2	13.0 \pm 2.9	0.2 \pm 0.8	0.4 \pm 0.4	0.384
Promoted food-getting frequency	17.4 \pm 7.1	20.4 \pm 9.5	3.0 \pm 2.7	18.9 \pm 6.6	20.7 \pm 10.5	1.8 \pm 2.7	-1.2 \pm 1.5	0.477
I would exercise if I had the time (attitude)	0.7 \pm 0.5	0.7 \pm 0.5	-0.0 \pm 0.0	0.7 \pm 0.5	0.7 \pm 0.5	-0.1 \pm 0.0	-0.0 \pm 0.1	0.660
Physical activity facilities, like a gym, are not available where I live (attitude)	0.2 \pm 0.4	0.2 \pm 0.4	0.1 \pm 0.2	0.1 \pm 0.3	0.3 \pm 0.5	0.1 \pm 0.2	0.1 \pm 0.0	0.015*
Food Preparation	4.1 \pm 5.0	6.2 \pm 4.1	2.1 \pm 0.8	2.6 \pm 4.4	6.8 \pm 4.0	4.2 \pm 1.6	2.2 \pm 1.7	0.274

*Significantly different between D and I communities

APPENDIX A

**RESULTS & DISCUSSION FOR HOUSEHOLD PATTERNS OF FOOD AND PHYSICAL
ACTIVITY, HOUSEHOLD ENVIRONMENT, HEALTH ATTITUDE, PROMOTED FOOD
GETTING FREQUENCY, & HEALTHY FOOD PREPARATION METHODS SCALES**

A1. Results

Household Patterns of Food and Physical Activity. A summary of the HPFPA activity scale at baseline is shown in **Table A1.1**. In general, the majority of respondents indicated that they were performing all of the indicated behaviors “some of the time” or “most of the time.”

Household Environment. **Table A1.2** summarizes the household environment scale at baseline. The majority of respondents indicated that they were performing all of the indicated behaviors “some of the time” or “most of the time.”

Health Attitude. **Table A1.3** summarizes the two Health Attitude questions retained from the original eight item scale. Approximately 70% of respondents said that they would exercise if they had the time. One fifth (20.5%) of respondents stated that PA facilities were not available where they lived.

Promoted Food-getting Frequency. Baseline PFGF score is shown in **Table A1.4**. Most of the respondents (>50%) answered that they had gotten the food or beverage “0 or never” times in the last 30 days for seven of the 22 items (game meat, fish and seafood, cooking spray, skim milk, other milks, sugar-free drinks, and calorie-free sweeteners). Most of the respondents replied “1-5” times for the remaining 15 items.

Healthy Food Preparation Methods. A summary of Food Preparation methods at baseline is shown in **Table A1.5**. For baseline food preparation score, the majority of respondents’ primary cooking methods added fat for fish and potatoes, and neither added nor removed fat for beef, chicken, or pork, and vegetables. The majority of respondents’ secondary cooking methods neither added nor removed fat for pork, potatoes, and vegetables, and removed fat for beef, chicken, and fish. The most common food preparation methods were deep fried in oil, lard, or shortening, and microwaved, baked, or broiled without added fat.

A2. Discussion

The HPFPA score at baseline indicated that the majority of the respondents and their families engaged in all of the behaviors either some of the time or most of the time. This did not change significantly from baseline to follow-up in either Delayed or Immediate Intervention groups, nor was there a significant intervention affect comparing Immediate to Delayed Intervention groups. Intervention materials did not specifically focus on this domain as a main concept, but rather as a secondary message. It is possible that this approach did not generate enough exposure or emphasis to result in a positive impact. Additionally, intervention messages focused on this domain did not explicitly link the behaviors back to the overall message of improving dietary intake and exercising more to prevent obesity. For example, a display board suggested using a shopping list to help plan meals, and OPREVENT interventionists gave out shopping list notepads as freebies. However, the fact that using a grocery list is associated with higher quality food choices and lower body weights³⁸ was not explained. The same could be true for bringing home prepared food from fast-food restaurants; the association between consumption of fast-food and obesity^{39,40} was not described. Without these connection, respondents may not have been motivated to adopt this behavior.

The Household Environment score also indicated that the majority of respondents and their families experienced the indicated behavior either some of the time or most of the time at baseline, and a DiD analysis revealed no significant intervention affect comparing Immediate to Delayed Intervention groups. Like HPFPA, this domain was not a primary focus of intervention content, and therefore an intervention impact should not necessarily have been expected.

For the two extracted Health Attitude questions, approximately 70% of respondents indicated that they would exercise if they had the time and 21% said that PA facilities were not available to them where they live at baseline. The intervention had no impact on these estimates from baseline to follow-up in either intervention group, and there was no significant intervention affect comparing Immediate to Delayed Intervention groups. This finding reveals that time may be a significant barrier for the OPREVENT evaluation sample. It also indicates that residents may

need to be better informed of PA facilities available for their use. All OPREVENT communities had at least one fitness center available to reservation residents free of cost.

The PFGF score was low at baseline, with an average of 19 points out of a possible 88, for a score of 21.6%. This is consistent with findings from AHS, NHS, and HFN, all of which found baseline scores ranging from approximately 20% - 27%^{9,11,12,21}. The DiD estimate for PFGF was not significant comparing Immediate to Delayed Intervention groups, indicating that the intervention had no effect on the promoted food purchasing habits of respondents.

Finally, the Healthy Food Preparation score was also low, with an average of 5.7 out of a possible high score of 24 at baseline. The most common food preparation methods at baseline were deep fried in oil, lard, or shortening, and microwaved, baked, or broiled without added fat. This score did not change significantly from baseline to follow-up by intervention group, and there was significant intervention affect comparing Immediate to Delayed Intervention groups. This finding appears to be in line with the low knowledge score related to knowing which cooking method added the least amount of fat when cooking. It is possible that respondents would choose healthier cooking methods if they knew which ones added less fat. The OPREVENT intervention attempted to address this knowledge and skill gap through cooking demonstrations throughout the intervention, including a demonstration specifically exhibiting how to cook ground meat without added fat and then rinse in water. This demonstration was performed primarily in community food stores, but also in community and senior centers. It is possible that community members who were exposed to the demonstrations did not belong to the OPREVENT evaluation sample.

Table A1.1: Household patterns of food and physical activity scale at baseline in the OPREVENT evaluation sample

Question: In the last 30 days, how often did...	Never	Hardly ever	Some of the time	Most of the time
1. You use a shopping list or plan your meals in advance before you went shopping?	13.4	11.5	39.5	35.6
2. People in your home eat a meal together, like dinner?	1.2	8.1	26.2	64.6
3. You or someone in your household bring home prepared foods from fast food restaurants, carry-out restaurants, delis, or other types of restaurants for the family?	10.0	35.4	49.6	5.0
4. Your children or other household members help you prepare meals?	13.9	18.1	43.5	24.6
5. Some or all of your household members engage in a physical activity such as going for a walk together?	15.4	19.6	43.9	21.2
Average promoted food-getting frequency score (mean \pm SD)	9.5 \pm 2.4			

Table A1.2: Household environment scale at baseline in the OPREVENT evaluation sample

Question: In your household, how often...	Never	Hardly ever	Some of the time	Most of the time
1. Are there clear rules for members to do things like cooking or childcare?	29.7	13.9	30.5	25.9
2. Are activities scheduled to do things together like playing sports/games or going out for a movie?	17.7	25.8	39.2	17.3
3. Are there duties or responsibilities for everyone, like for grocery shopping?	18.2	16.3	37.6	27.9
4. Do members engage in activities, like community or family events?	5.8	16.9	47.7	29.6
5. Is it hard finding time to spend together on weekdays?	23.9	22.0	34.8	19.3
6. Do members find time to spend together on weekends?	6.9	14.6	36.2	42.3
7. Do members openly talk about feelings with each other?	9.2	16.2	34.6	40.0
8. Do members have difficulty talking freely about problems with each other?	20.9	31.7	38.2	9.3
Average household environment score (mean \pm SD)	12.9 \pm 3.5			

Table A1.3: Health attitudes at baseline in the OPREVENT evaluation sample

Question: Do you agree or disagree with the statement?	Agree (%)
1. I would exercise if I had the time.	67.9
2. Physical activity facilities, like a gym, are not available where I live.	20.5

Table A1.4: Promoted food-getting frequency at baseline in the OPREVENT evaluation sample

Question: in the last 30 days, how often did you get...	Number of times respondent got each item in the last 30 days (%)				
	0	1-5	6-10	11-15	>15
6. Fresh fruits	2.4	63.1	21.1	5.7	7.7
7. Frozen or canned fruits	27.0	59.0	8.9	3.4	2.0
8. Fresh vegetables and greens	7.1	56.6	21.9	8.4	6.1
9. Frozen or canned vegetables and greens	20.6	57.8	14.2	5.4	2.0
10. Beans and peas (canned or dried)	21.6	64.9	10.1	1.7	1.7
11. Dried fruits and nuts	39.5	50.0	8.5	0.7	1.4
12. 100% whole wheat breads and pastas	13.2	53.9	22.0	6.8	4.1
13. Hot cereals (like Cream of Wheat, oatmeal, or Atole)	24.0	60.5	8.8	6.1	0.7
14. Low-sugar, high-fiber cereals (like Cheerios)	25.7	61.5	8.5	3.7	0.7
15. Poultry (like chicken or turkey)	13.9	63.4	17.0	4.4	1.4
16. Game meat (like venison, elk, buffalo, or moose)	73.8	23.5	2.0	0.34	0.34
17. Fish or seafood	57.6	36.6	4.8	0.3	0.7
18. Baked chips or Graham crackers (low-fat or low-sugar snacks)	32.8	56.8	7.8	2.0	0.7
19. Low-fat bologna or turkey deli slices	38.1	53.4	6.1	1.0	1.4
20. Cooking spray (like Pam)	57.2	33.3	6.7	1.4	1.4
21. Low-fat milks (1% or 2%, including Lactaid)	27.0	43.7	17.4	8.2	3.8
22. Skim milk (including Lactaid)	82.0	13.6	3.1	1.0	0.3
23. Other milks (including soy milk, rice milk)	80.4	15.9	3.0	0.3	0.3
24. Sugar-free drinks (Crystal Light)	48.6	34.4	10.2	3.1	3.7
25. Water (plain, bottled)	21.8	34.4	16.0	12.9	15.0
26. Calorie-free sweeteners (like Equal or Sweet n' Low)	61.2	30.4	2.4	2.4	3.7
27. Low-fat or light dressings (like Miracle Whip or light mayo)	44.0	49.8	4.4	1.0	0.7
Average promoted food-getting frequency score (mean \pm SD)			19.2 \pm 8.7		

Table A1.5: Baseline food preparation methods of OPREVENT evaluation sample

Food	Removes fat (%) ^a		Neither adds nor removes fat (%) ^b		Adds fat (%) ^c	
	Primary method	Secondary method	Primary method	Secondary method	Primary method	Secondary method
Beef	6.7	4.6	43.3	33.1	50.0	62.3
Chicken	30.2	18.4	26.1	26.8	43.8	54.7
Pork	32.4	14.7	34.8	24.8	32.8	60.5
Fish	44.1	20.0	11.9	16.7	44.1	63.3
Potatoes	48.8	26.1	17.0	27.0	34.3	46.9
Vegetables	5.1	4.3	27.1	26.6	67.9	69.1
Average food preparation method score (mean \pm SD)				5.7 \pm 4.3		

^aIncludes: Pan-fried in own fat or water and drained; Pan-fried in own fat, drained, and rinsed; Boiled and drained or skimmed

^bIncludes: Microwaved, baked, or broiled without added fat; Cooked with cooking spray only; Grilled; Steamed; Smoked; Boiled or crockpot; Pan-fried in own fat or water

^cIncludes: Deep-fried in oil, lard, or shortening; Pan-fried in oil, lard, or shortening; Microwaved, baked, or broiled with added fat

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CHAPTER 7: DISCUSSION

The following chapter provides a perspective on multi-level, multi-component (MLMC) obesity interventions in American Indian (AI) populations, and their potential for impact. This is followed by a summary of intervention findings and draws conclusions from the research presented in this dissertation. Strengths, limitations, and implication for future research will be discussed.

7.1 Summary of Main Findings

The goal of this dissertation was to determine whether a large, culturally acceptable MLMC adult obesity intervention could improve dietary intake, physical activity (PA) levels, and related psychosocial variables in AI adults through implementation in schools, food stores, worksites, and media with a focus on primary behavioral risk factors for obesity. Specifically, an impact analysis of the OPREVENT program on dietary intake, PA, and psychosocial outcomes was conducted, as well as evaluation of whether exposure to the intervention affected degree of impact.

This dissertation began with an overview of the OPREVENT study design, development, and implementation. As a protocol paper, there were no data analyses or results to report. Instead, the purpose of this chapter was to describe the study design of OPREVENT in rich detail such that it could be used as a guide for future research. The conceptual framework was presented and behavioral theories explained to justify the MLMC design and the intervention focus on constructs within the each of the community, institutional, family, and individual levels. Detailed information on each tribal community, including relative size, remoteness of location, socioeconomic status, education, and access to resources utilized in the intervention such as schools, worksites, and food stores was provided. Recruitment and sampling methods were described, as well as power and sample size calculations and community randomization process.

The importance of obtaining tribal approvals and providing period updates to each tribal community was emphasized. The formative phase activities were described in detail, and linked to the development of the intervention phases and messages for each intervention component. Finally, data collection instruments and intervention activities were described in detail.

Much of the literature to date consists of interventions implemented within select environmental levels and institutions as opposed to a MLMC approach such as the one employed in OPREVENT. A few of these interventions are able to produce positive outcomes, however they are focused to small segments of the population, do not have large sample sizes, and generally do not demonstrate sustainability¹⁻⁹. One particular study that did have a large sample size did not show an significant impact¹⁰. Recently, researchers have moved away from this segmented approach and begun to implement interventions within multiple environmental levels and community institutions. These interventions are developed with continual input from the communities in which they are implemented, tend to have larger sample sizes, and have the potential to address several of the factors contributing to obesity burden within these communities, such as low healthy food access and availability, barriers to physical activity, and low social support for healthy behavioral changes. However, despite the comprehensiveness of such interventions, there have been mixed results^{11,12}. Although these larger interventions have the potential to impact more individuals, it is also possible for resources to be spread too thin as more components, materials, and activities are added. The OPREVENT intervention included protocol for process data collection from the start to help monitor these factors and lessen this possibility. While the process data was not available for analysis in this dissertation, our exposure evaluation helped to identify specific intervention components and activities where implementation standards may not have been met.

Exposure to the intervention was assessed at follow-up. Using the Intervention Exposure Evaluation, respondents were asked whether they had seen specific intervention materials or

participated in intervention activities such as taste tests, cooking demonstrations, or the pedometer challenge.

Analysis found that overall exposure was low. Out of all exposure categories, only the OPREVENT logo and food store categories received scores higher than half of the possible points (3.5 out of 5, and 27.3 out of 47, respectively). Despite this, higher exposure to the intervention resulted in some trends towards improved dietary intake. With each increasing quartile of exposure, daily servings of all promoted foods increased, daily servings of all discouraged foods decreased, and daily servings of dark leafy greens increased. Additionally, changes in time per week engaged in walking and moderate activity both trended towards significance among participants within the third quartile of exposure.

This analysis allowed us to evaluate the relative strengths and weaknesses of each intervention component. We measured exposure to each type of intervention material as well to schools, worksites, and food stores individually. Although the purpose of large MLMC interventions is to evaluate and determine their effectiveness as a whole, assessing each component separately allowed us to identify areas for improvement. We identified which materials received the most exposure, and determined which components were likely to result in the most exposure to materials and intervention activities. For the OPREVENT program, the food store component received one of the highest exposure scores. Many intervention materials including posters, educational displays, flyers, and booklets were displayed in food stores, and therefore exposure to these materials was higher as well. Most interactive sessions and giveaway opportunities also took place within food stores, and these categories also received higher exposure scores. The school and worksite components received low exposure scores even though these components consisted of intensive intervention activities.

There could be many reasons for this low exposure. It is possible that our randomly selected respondents did not work at the intervention worksites, and did not have children in grades 2 – 6 at intervention schools. In fact, the majority (61.8%) of Immediate Intervention

respondents in our evaluation sample reported having zero children attending school between grades 2 – 6 during the year of the OPREVENT program. Additionally, the school component relied on children acting as change agents to learn from the OPREVENT curriculum at school and then take that information home to share with adults in their household. While previous studies support this method, especially for health behavior changes such as decreased fat consumption, healthier grocery store purchasing habits, and increased fruit and vegetable intake¹³⁻¹⁷, it is possible that it was ineffective in this population. In many AI cultures, children are taught self-sufficiency at an early age and to assist with household chores, food preparation, and family care¹⁸. Traditionally, responsibility and respect are accorded to every age group, from children to Elders, as each is regarded as fulfilling critical functions within the community¹⁹. This would suggest that children would be viable as change agents within AI cultures; however, it could be that transitions into a more modern society have diminished these traditional beliefs. Results from formative in-depth interviews investigating the role of children as change agents within OPREVENT's Michigan tribal communities identified only six children under the age of 13 acting as change agents within the two communities²⁰. Although this does represent potential, it may not have been enough to influence outcomes. Finally, anecdotal evidence suggests that the school curriculum was not delivered consistently or with high fidelity.

The OPREVENT program was designed to increase PA, improve dietary intake, and promote changes in psychosocial variables (PSV) and food and PA related behaviors. The PA messages were emphasized primarily in worksites throughout two of the six phases. They described different types of PA such as moderate and vigorous, recommended that adults spend at least 150min per week engaged in PA, and made suggestions for traditional forms of PA such as traditional dancing. Pedometer challenges were also implemented within worksites to encourage teamwork and create an environment supportive of PA and other healthy behaviors. To improve dietary intake, most of the OPREVENT messages aimed to positively influence dietary intake in ways that would decrease risk of overweight and obesity. Intervention messages focused on

depromoting “problem foods” and promoting healthier alternatives identified during the formative phase. Education was also provided on healthy portion sizes of foods and beverages and food components such as fat, sugar, sodium, and fiber. Finally, PSV and food and PA related behaviors were targeted using SCT as the foundation for intervention messages. Self-efficacy, knowledge, and intentions were specifically targeted.

Responses from the 299 respondents with both baseline and follow-up surveys were used to evaluate changes in PA, dietary intake, and PSV. An analysis of PA outcomes determined that the OPREVENT program did not significantly impact any of the PA outcome variables. No changes were observed in frequency, duration, volume, or physical activity levels. However, there was a large increase in volume of PA that shifted Immediate Intervention respondents from the “sedentary/low active” category to the “moderately active” category. It is widely supported that some PA is better than no PA²¹, therefore a shift from sedentary/low active to moderately active is an important achievement. Similar findings have been reported in the literature, yet study methodologies have differed dramatically²², leading to an overall inconclusive state of evidence for the potential of large, MLMC interventions to sustainably improve PA.

The OPREVENT program significantly decreased the daily servings of regular soda by nearly 7oz among Immediate Intervention respondents. Through energy balance calculations, it was determined that a decrease of this amount could result in a weight loss of just under ten pounds per year, which would represent a clinically important decrease in our evaluation sample²³. These findings show that a large, MLMC intervention led to positive improvements in beverage intake in AI adults that could potentially have significant and clinically important impacts on their overall health and risk of overweight and obesity. This finding is especially important in the context of today’s food environment as research is confirming links between intake of added sugars, particularly those found in sugar-sweetened beverages (SSBs), and diet-related chronic diseases²⁴⁻³¹. In fact, findings from the large prospective PREMIER trial found

that reductions in liquid calories had a stronger effect on weight loss than reductions in solid calories³².

Other interventions have demonstrated decreases in SSB intake, as well. Most research to date has focused on children and adolescents, and a number of school-based interventions have been shown to decrease SSB intake³³⁻³⁷, and some have also been able to show concurrent changes in measure of BMI³⁸⁻⁴¹. In another study, a point-of-purchase price increase on regular soda paired with an education intervention was successful in reducing sales in a hospital cafeteria, though actual consumption was not measured and analyses found no independent effect of the education component⁴². Results similar to those found in the present analysis have also been reported in other comparable studies in AI adults⁴³⁻⁴⁵, but our results represent the largest daily decrease observed in the literature to date.

We had also hypothesized that the intervention would lead to significant improvements in other dietary factors, such as increased consumption of promoted foods and decreased consumption of other discouraged foods. However, these changes were not observed. We were also unable to assess energy or nutrient intake, or compare dietary intake within our study communities to national guidelines.

Finally, baseline analysis revealed an evaluation sample with high knowledge and self-efficacy scores at baseline, although knowledge and self-efficacy were lower for certain individual questions within each scale. Community members were concerned about their health, engaged in learning more about health and food related topics, and were fairly confident in their abilities to engage in healthy behaviors. Many of the OPREVENT promoted foods were already available in the five communities, suggesting that there was a certain degree of interest and consumer demand at baseline. Difference-in-differences analysis did not find any significant changes in these psychosocial and behavior variables from baseline to follow-up in either group.

An analysis of the Semi-quantitative Food Frequency Questionnaire (QFFQ) in Chapter 5 appears to support the finding of low self-efficacy in regards to choosing salad instead of French

fries at a restaurant, as there was no intervention impact on daily servings of salads or fried potatoes. Given the well-documented importance of self-efficacy as the core determinant in SCT as well as an important factor in behavioral interventions^{3,46-48}, one would expect to have seen significant changes in dietary and PA behaviors from baseline to follow-up due to the generally high self-efficacy observed for nine of the 12 behaviors included in the scale. However, this was not the case, as analyses both here and elsewhere (Chapters 4 and 5) do not show significant changes in related dietary outcomes (smaller portion sizes, increased daily servings of whole wheat bread, high-fiber cereal or lean meats) or PA outcomes (increased frequency, duration, or METs/week spend walking). Although the instructions for the Self-efficacy scale specifically asked respondents to answer according to whether or not they believed they could perform the particular behavior given their current situation (free time, personal and family preferences and obligations, affordability), it is possible that these factors were not considered when answering. While this is just speculation, it could be that when it came down to actually performing the behaviors, respondents found that although they believed they could perform the behaviors in theory, there were actually several perceived barriers preventing them from doing so. As a result, reported self-efficacy was high yet corresponding changes in behavior were not observed. However, this is only speculation.

When it came to knowledge, the majority of respondents did not know the recommended amount of time an adult should be physically active each day. Supporting analysis in Chapter 4 found that there were no changes in any PA outcomes. It is possible that intervention messages were inadequate in providing information and recommendations in regards to recommended time for adults to be active each day, and therefore failed to create the precondition for change in this behavior, which could account for both no change in knowledge nor action related to this domain.

Intentions to choose a healthier drink over regular soda were high at baseline, with 72.4% choosing water. Although there was no significant intervention impact on this measure of healthy intentions, high baseline values do support previous findings from analysis of the OPREVENT

QFFQ in Chapter 5. A DiD analysis of daily servings of discouraged foods found that respondents in Immediate Intervention communities decreased their daily intake of regular soda more than respondents in Delayed Intervention communities. It is possible that because intentions were already quite high for this outcome, respondents were more readily accepting of intervention messages discouraging consumption of regular soda and promoting water. Intentions to go for a walk instead of watch TV/use the computer or take a nap were low, as only 49.2% said they would go for a walk. This too is in line with previous findings from Chapter 4, in which a DiD analysis did not reveal any significant changes from baseline to follow-up for any PA outcomes, such as frequency or duration walking. It is possible that intervention messages focused more on nutrition than on PA, thus limiting the potential for impact.

7.2 Strengths and Limitations

7.2.1 Strengths

The OPREVENT program was the first MLMC adult obesity intervention to take place in AI communities. There have been many obesity interventions in AI children, and even several in AI adults that made use of similar intervention locations such as schools or food stores, but none that have attempted an MLMC design of such magnitude. This dissertation provided novel data to support and expand our understanding of how large-scale environmental interventions may influence dietary and PA behaviors and related psychosocial determinants.

The study was methodologically thorough. The extensive formative phase strengthened intervention materials and messages and ensured that all aspects of the study were culturally appropriate. Community workshops, in-depth interviews, and focus groups each contributed to the identification of problem foods, healthier alternatives, and food and PA behaviors to target. Collaboration with tribal communities throughout the formative phase was essential, and helped to establish ownership among community members and rapport with the study team, as well as to

lay the foundations of sustainability for the future. Hiring of tribal community members as data collectors and interventionists helped to establish trust within communities and ensured that community members felt comfortable and receptive to intervention activities such as data collection interviews and interactive sessions. Tribal members were engaged in each phase of the intervention, from formative phase to completion.

Another strength of this work is the depth and breadth of information gathered at baseline and follow-up that are beyond the scope of this dissertation. Process data will be analyzed to determine dose, reach, and fidelity. This evaluation will be incredibly valuable to the interpretation and understanding of the findings within this dissertation. At this time, we can only speculate as to how these variables may have impacted the outcomes of this intervention.

Finally, the formative process and MLMC design of the OPREVENT program provide a framework and structure that can be used to aid in the development of other similar health behavior change interventions. This approach and design can be applied to a wide range of populations and target behaviors. Additionally, the model allows for an intervention that is non-exclusionary; there is opportunity to involve other age groups such as children, adolescents, and Elders, as well as other community institutions such as faith-based organizations and community recreation centers.

7.2.2 Limitations

Despite many strengths, there were numerous limitations as well. This study is limited in generalizability of findings and transferability of study design and methodology. There was high loss to follow-up (30%), and this could result in selection bias. Additionally, the OPREVENT program was developed specifically for AI adults, and then painstakingly customized to the five participating tribal communities. Therefore, we cannot say with certainty that results obtained in this analysis could be expected in a different population or setting. However, this dissertation has

attempted to lessen this limitation by providing detailed description of intervention development, implementation, and evaluation, context in which the evaluation took place, and descriptive information for each community. Generalizability and transferability to different populations and settings may be up to the discretion of the researcher. The counter argument is that development of an intervention that is non-specific to the point of being completely transferable to all populations ignores the strength inherent in culturally-tailored interventions. Interventions that are personalized to different cultures promote ownership and a sense of relatability that is otherwise absent, and may be key in the elimination of health disparities and promotion of health equity in certain minority populations.

Another limitation was the inability to treat this study as a randomized controlled trial. As noted throughout, the original OPREVENT program was powered for eight communities. However, due to budgetary constraints, the intervention was only implemented in five communities. Due to this change in study design, randomization was not guaranteed and we chose to proceed with the assumption that there were permanent average differences in treatment and control groups at baseline. These differences could confound the true treatment effect and result in biased results from an ordinary least squares regression. Therefore, the program was treated as a quasi-experimental pilot-study for which the most appropriate analytical model is a difference-in-differences (DiD) estimator. The DiD estimator is the difference in average outcome between the treatment group and the control group at follow-up (post-treatment) minus the difference in average outcome between the treatment group and the control group at baseline (pre-treatment). The difference estimator for the pre-treatment period is used to estimate the permanent differences that existed between the groups at baseline, which is then subtracted away from the post-treatment period estimator for an unbiased true treatment effect. This is important in study designs such as ours where randomization has not already removed those differences. Alternatively, the DiD estimator can be interpreted as a simple difference estimator between the actual treatment effect in the treatment group and the treatment effect that would have occurred in

the treatment group had there been no treatment. This is the counterfactual, which should be represented by the average change in the control group. However, for this assumption to hold, the pre-treatment trends for both groups should be the same. Our study was limited in that we only obtained one pre-treatment measurement for each respondent, not the multiple that would be needed to confirm such a trend. Therefore, even though the DiD estimator was the best choice for our quasi-experimental data, there was still a possibility of bias.

There were additional limitations pertaining to the evaluation instruments used for data collection. Self-reported data is susceptible to response bias. Also, as noted throughout this work, the data collection instruments were adapted from validated measures presented in the literature^{44,49-56}. However, none were validated within our specific population either before or after modifications were made. This brings their reliability and internal consistency into question, especially for the PSV scales for which the Cronbach's alphas were relatively low. Additionally, for some instruments such as the International Physical Activity Questionnaire-Short Form, the literature is inconclusive as to whether it should be used for intervention evaluation⁵⁷⁻⁶⁰.

Finally, sampling was community based. Eligibility criteria only specified that respondents be between the ages of 18 – 65 and either the main food shopper or preparer. This did not allow us to specifically sample respondents we knew would be exposed to all intervention components. However, the goal of the evaluation was to determine how a large, environmental, MLMC intervention could impact the average community member, not those specifically chosen for potential to be exposed, and therefore community based sampling was the appropriate method.

7.3 Implications for Future Research, Policy, and Practice

The research presented within this dissertation provides a first of its kind impact analysis of a MLMC adult obesity intervention in AI on dietary intake, PA, and psychosocial variables. It

provides valuable information as to the effectiveness of such programs, and affords many insights for improvement as well as next steps and synthesis of results. To our knowledge, this is the only program of its kind to report changes in daily servings of food and beverages. It is also the first study to engage with these particular communities in the Upper Midwest and to combine school, food store, community media, and worksite components into one large MLMC intervention.

Large, MLMC interventions have a lot of potential for impact, yet the literature has shown that they are susceptible to several challenges. Evidence reveals that interventions of this scale may be difficult to implement with high intensity. Exposure for OPREVENT was low, there were limited significant outcomes, and anecdotal evidence suggests that the intervention was implemented with poor dose, reach, and fidelity. The scope of the intervention was large, and there may have been insufficient resources to implement each component sufficiently such that high exposure was guaranteed. Because of this, it is important to ensure that the intervention content and evaluation methods are developed and chosen based upon the most up to date and rigorous evidence. The following sections detail several implications for future research in this area.

7.3.1 Reduced Loss to Follow-up

The current evaluation found that 30% of the data were lost to follow-up. This high drop-out limited the size of the evaluation sample and the ability to detect significant outcomes while also reducing generalizability. Future research should investigate why there was high drop-out, and seek determine if there are factors unique to this population that may put AI at higher risk for drop-out. Attempts should be made to understand the factors influencing drop-out and retention, and strategies should be developed to retain respondents in the evaluation.

7.3.2 Improve Measurements for Dietary Intake and PA

Data from the QFFQ and IPAQ-SF were used to analyze intervention impact on dietary intake and PA, respectively. Both measures were imperfect, and efforts should be made to improve them should they be used in future studies. To limit misreporting, such as evidenced with the IPAQ-SF, instrument instructions need to be clear. Cultural modifications should be made, followed by validity and reliability testing. Related to this, improved data collector training protocol should be implemented. Structured trainings, supervised practice with actual community members, and scheduled in-service trainings could improve data collection form administration as well as inter-rater reliability, leading to overall lower incidence of misreporting.

7.3.3 Assessment of Other Variables and Relationships

This study used the Adult Impact Questionnaire (AIQ) to assess food and PA behaviors and related psychosocial constructs. We found that at baseline, the constructs most closely related to changes in diet and PA were already intermediate to high (intentions, knowledge, and self-efficacy). Therefore, intervention messages focused on improving these domains may not have been useful to many community members. Researchers should seek to understand if these constructs present differently in AI populations, and attempt to identify other constructs that may have a greater influence on healthy lifestyle behavior change including dietary intake and PA. There is also potential for many other relationships to be explored. The psychosocial variables analyzed in Chapter 6 likely predict the primary outcomes for dietary intake and PA, but also likely predict one other as well as related behaviors such as healthy food preparation and promoted food purchasing. There is evidence of this in the existing literature in AI and First Nation populations^{3,48}.

7.3.4 Selection of Promoted and Discouraged Foods

The promoted and discouraged food selected for the OPREVENT study were identified via workshops, focus groups, and in-depth interviews during the formative phase of the project. However, information supplied via these methods was not confirmed quantitatively within each community. For example, it is possible that workshop attendees felt that graham crackers would be an acceptable healthy snack item to replace potato chips but that other community members not present at workshops disagreed. To validate formative findings and ensure that intervention messages are appropriate and meaningful for participating communities, future researchers should consider cross-checking formative data with food storeowners in each community. Monthly sales records for the foods to be promoted and discouraged could help to support or refute workshop findings. Additionally, food storeowners need to be given a leading role in any food store-related intervention decisions. Many food storeowners will be reluctant to change their stock, or try new items that might not sell. Developing a list of healthier alternatives to problem foods that gives more than one option for each problem food will give food storeowners more control over stocking and sales outcomes. A wider range of options would allow the food storeowner to choose the item that represented the least financial risk; for example, a food storeowner could choose to stock either low-fat string cheese or low-fat yogurt as alternatives to full-fat dairy snacks.

7.3.5 Develop in-depth and integrated intervention materials and stronger components

The OPREVENT intervention components were developed based on methods that have shown to be successful, such as worksite wellness programs, children as change agents, and community media. However, positive outcomes from these methods were not observed in our sample. Work should be done to understand why these methods did not lead to more positive outcomes and whether other methods may be more appropriate in AI populations. This

understanding should then be applied to the development of stronger MLMC interventions in the future.

As noted throughout this work, there were several outcomes measured that were not expressly emphasized on intervention materials or during intervention activities. The intervention was founded on SCT, yet the core determinants of this theory were not main messages, but rather background themes. In other cases, a behavior was promoted but instructions and guidelines as to how to achieve the behavior were not provided. For example, telling someone to ‘eat more fruits and vegetables’ does not provide much direction. This message should be followed with supportive material, such as ‘have a vegetable every night at dinner,’ or ‘choose a salad instead of French fries.’ Information should also be provided on how to set goals for increased fruit and vegetable consumption, how to track and measure progress, and the positive outcomes that individuals can expect from adopting this health behavior, such as lowered cholesterol and decreased risk of heart disease. These messages should also be paired with intervention activities such as a cooking demonstration on how to purchase and prepare vegetables on a budget. Future intervention programs should consider an approach such as this to ensure that not just knowledge is being presented but that facilitators to achieve the behaviors are provided as well.

7.3.6 Expansion of MLMC model

The current MLMC model implemented in OPREVENT consisted of food store, worksite, school, and media components. There is quite a bit of potential for the inclusion of additional components at all environmental levels, and to implement the intervention for longer duration. Additional components could include faith-based organizations, senior centers, or youth organizations. Additional environmental levels could include policy, and in fact a policy level is being incorporated into the OPREVENT2 intervention. Implementing the intervention for a

longer duration will allow for changes in anthropometric variables, which may require more time to change, such as weight and BMI.

7.3.7 Sustainability

Finally, sustainability should be considered throughout every step of the intervention, from the formative phase to dissemination of findings. Sustainability is especially important for interventions being implemented in small communities that often have few resources of their own. For the OPREVENT intervention, sustainability was accounted for through the hiring of local community members for data collection and intervention implementation, as well as through working with local food stores, worksites, schools, and media outlets to implement the intervention and generate a sense of ownership. However, further steps can be taken. The use of social media in intervention programs is an exciting trend in intervention design that could promote sustainability. Many programs and interventions are using social media to engage participants, spread awareness, increase impact, and promote healthy lifestyle behaviors, as social media allows for the dissemination of information while encouraging social support and reshaping social norms^{61,62}. It is a way to bring communities together to share information and materials in real time, enabling both interventionists and community members to stay up to date and informed on topics related to the health behavior being addressed. Through our experience working with AI communities, it has become clear that a social media component could make a valuable addition to our current MLMC intervention model.

Policy-level approaches should also be considered. Supporting policy change with communities may lead to the structural and environmental changes that would sustain the intervention. Bringing stakeholders together, aligning with existing health programs, and promoting health policies within community schools, worksites, and food stores could sustain and promote long-term changes within the communities. A recent survey assessing feasibility and

readiness to address obesity through policy in AI reservations found that communities identified “increasing the availability of healthy foods in tribal venues” as the most feasible strategy⁶³. This finding supports what OPREVENT has already been able to do through working with tribal food stores to stock healthier alternatives to problem foods, and distinguishes a key starting point for integration with a policy component in future work.

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CURRICULUM VITAE

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EDUCATION AND TRAINING

2012- 2017

PhD, Human Nutrition

The Johns Hopkins University, Bloomberg School of Public Health

Baltimore, Maryland

Dissertation: Obesity Prevention Among American Indian Adults: Impact

Evaluation of a Multi-level, Multi-component Intervention

Advisor: Laura E. Caulfield, PhD

2010-2012

MS, Kinesiology

James Madison University

Harrisonburg, Virginia

Thesis: The effect of garlic supplementation on flow-mediated dilation after acute maximal exercise

Advisor: M. Kent Todd, PhD

GPA: 3.93/4.00

2009-2010

Graduate Certificate, Dietetic Internship

University of Alaska Anchorage

Anchorage, Alaska

Internship Coordinator: Carrie King, RD, LD, CDE

Rural and Native health focus. In addition to the standard clinical and food service rotations at Alaska Regional Hospital, WIC rotation with the Municipality of Anchorage WIC, and management rotation at Alaska Native Medical Center, included the following culturally focused rotations and responsibilities:

- Outpatient: Provided nutrition education exclusively to Alaska Native individuals and taught a Diabetes Gathering class on HbA1c at Alaska Native Medical Center South Central Foundation
- Rural: Traveled to Barrow, AK and Point Lay, AK to provide WIC education and care for Alaska Natives in rural villages, developed nutritional brochures for Native foods (bowhead whale), reviewed dietary satisfaction at the local senior center, and taught an infant feeding class with North Slope Borough WIC
- Health promotion: Oversaw intake and sorting of donations for the Food Bank of Alaska
- School food service: Developed a four week cycle day care menu to accommodate new USDA school lunch standards, tested new products

using low-energy density substitutions (black beans in brownies and cookies) in local middle schools, and presented on career day at a local high school in the Matanuska-Susitna School District

GPA: 4.00/4.00

2005-2009 BS, Food Science, Graduated Cum Laude with honors
Clemson University
Clemson, South Carolina
GPA: 3.40/4.00

TEACHING EXPERIENCE

2017-current Instructor, California State University-East Bay, Department of Kinesiology
Hayward, California
Responsibilities: Develop and deliver undergraduate and graduate courses in kinesiology, including **Clinical Exercise Physiology, Training for Physical Performance, and Exercise Physiology Lab**
Supervisor: Paul Carpenter, PhD

2015-2016 Gordis Teaching Fellowship, The Johns Hopkins University
Baltimore, Maryland
Responsibilities: Developed and taught an original course for undergraduate students in the Public Health Studies program at Johns Hopkins University, entitled **Ethics of Obesity Prevention**
Supervisor: Meika Smart, DrPH, MHS

- 2013- 2015 Teaching Assistant, The Johns Hopkins University, Bloomberg School of Public Health
Baltimore, Maryland
- Responsibilities: Provided assistance, met with students, graded assignments, and scheduled speakers for **Principles of Human Nutrition, Critical Thinking in Nutrition I, Critical Thinking in Nutrition II, and Food Culture and Nutrition**. These courses are required for students studying nutrition at JHU. They provide basic understanding of human nutrition introduce students to research within the field, and study human food use patterns and their nutritional consequences.
- Supervisors: Dr. Ben Caballero, MD, PhD; Dr. Lawrence Cheskin, MD; Joel Gittelsohn, PhD
- 2010-2012 Teaching Assistant, James Madison University
Harrisonburg, Virginia
- Responsibilities: Lectured weekly, instructed the laboratory sessions, and graded assignments of **General Kinesiology 100: Lifetime Fitness and Wellness**. This was a General Education course designed to help students adopt and maintain the behaviors associated with an active and healthy lifestyle. Students learned the importance of maintaining wellness through a physically active lifestyle. Through lectures and labs, students developed the behavioral patterns consistent with the current knowledge base in fitness and wellness. Lectures included 90 students on average, with 30 students in activity lab sections.
- Supervisor: Jana Walters, MS

PROFESSIONAL EXPERIENCE

- 2014- 2017 Johns Hopkins Leadership Education in Adolescent Health Fellowship,
The Johns Hopkins University, School of Medicine
Baltimore, Maryland
Responsibilities: Participated in adolescent grand rounds at the Johns Hopkins
Children's Center; presented on nutrition as it relates to adolescent health
Supervisor: Dr. Hoover Adger, MD
- 2014-2016 Preparing Future Faculty Teaching Academy (PFFTA), The Johns
Hopkins University, Bloomberg School of Public Health
Baltimore, Maryland
Responsibilities: Over two years, completed the necessary program
requirements to receive a certificate indicating competence in pedagogy,
educational models, and teaching and assessment skills
Supervisor: Kelly Clark
- 2014- 2015 Research Assistant, The Johns Hopkins University, Bloomberg School of
Public Health, Center for a Livable Future
Baltimore, Maryland
Responsibilities: Assisted the Johns Hopkins Healthy Monday Project (in
association with Columbia Mailman School of Public Health and Maxwell
School at Syracuse) with development and implementation of the M-TRIMM
(Monday-Tailored Rapid Interactive Mobile Messaging) nutrition and physical
activity component
Supervisor: Dr. Lawrence Cheskin, MD; Laura Fuentes

2014- 2017	<p>Research assistant, The Johns Hopkins University, Bloomberg School of Public Health</p> <p>Baltimore, Maryland</p> <p><u>Responsibilities:</u> Post-intervention data collection and analysis for the OPREVENT study; publication manager for all manuscript publications associated with the OPREVENT study; interventionist and data collection training and development of the social media component for the OPREVENT2 study. The overall goal of the two projects is the reduction of obesity in adult American Indian participants.</p> <p><u>Supervisor:</u> Joel Gittelsohn, PhD</p>
2013- 2016	<p>Johnson & Johnson Community Health Care Scholar, The Johns Hopkins University, Bloomberg School of Public Health</p> <p>Baltimore, Maryland</p> <p><u>Responsibilities:</u> Worked with community healthcare organization and J&J Community Health Care Program grantee Erie Neighborhood House to provide evidence-based technical assistance to improve in-house capacity for monitoring and evaluation</p> <p><u>Supervisor:</u> Fannie Fonseca-Becker, DrPH, RD</p>
2013	<p>Research assistant, The Johns Hopkins University, Bloomberg School of Public Health, Johns Hopkins Center for American Indian Health</p> <p>Baltimore, Maryland</p> <p><u>Responsibilities:</u> Reviewed nutrition curriculums for ongoing research projects; reviewed FFQ and physical activity data and assist with developing and implementing a quality assurance plan</p>

Supervisors: Allison Barlow, PhD; Rachel Strom, MPH

2012- 2015 RD and research assistant, The Johns Hopkins University, Bloomberg School of Public Health, Johns Hopkins Weight Management Center
Baltimore, Maryland

Responsibilities: Counseled weight-loss patients in nutrition and exercise program coordination; content development and evaluation for text message-based behavioral intervention programs; conduct nutrition and exercise assessments for current research projects; project manager for the “Fostering Weight Control among Underserved Adults in Baltimore City: A Community Partnership” study.

Supervisor: Dr. Lawrence Cheskin, MD

2010-2012 Registered Dietitian, James Madison University, Morrison Bruce Center for the Promotion of Physical Activity for Girls and Women
Harrisonburg, Virginia

Responsibilities: Lectured for Mother Daughter Day and Alumni Health and Fitness Day programs; performed 24-hr dietary recalls; assisted with nutritional components of ongoing research projects

Supervisor: Judith Flohr, PhD

2011 Counselor, Wellspring Camp La Jolla
San Diego, California

Responsibilities: Weight-loss counselor for 12-17 year old adolescents

Supervisor: Jude Wood

- 2010 Nutrition for Athletic Performance. Guest lecture on sports nutrition for the Randolph-Macon College women's lacrosse team
Ashland, Virginia
- 2010 Clinical Registered Dietitian, Alaska Regional Hospital
Anchorage, Alaska
Responsibilities: Provided clinical nutrition to patients in ICU, PCU, Rehabilitation, Cardiac, Oncology and Labor and Delivery Departments
Supervisor: Naomi Chapman
- 2007 Intern, Summercise, Norton Sound Health Corporation
Nome, Alaska
Responsibilities: Taught nutrition and fitness classes to predominately Alaska Native children; assisted with diabetes prevention programs through the Chronic Care Active Management and Prevention (CAMP) department; participated in traditional foods promotional activities within the community
Supervisor: Kelly Keyes, RD

PROFESSIONAL ACTIVITIES

Presentations & Posters

2016 American Public Health Association Annual Conference; Denver, CO: October 31
Round-table Discussion: "A multi-level, multi-component adult obesity intervention approach leads to increased physical activity in three American Indian communities." **Redmond L, MS,**

RD; Pardilla M, MPH, MSW; Swartz J; Eckmann T, MPH; Gittelsohn J, PhD.

2016 American Academy of Nutrition and Dietetics Food and Nutrition Conference and Exposition; Boston, MA: October 16

Poster: “Multi-level, multi-component obesity interventions lead to health behavior change in American Indian communities.” **Redmond L, MS, RD**; Pardilla M, MPH, MSW; Swartz J; Eckmann T, MPH; Gittelsohn J, PhD.

Received Outstanding Abstract Award

2016 Experimental Biology Annual Conference; San Diego, CA: April 5

Presentation: “Increasing Physical Activity in American Indian Adults: Results from a Multi-institutional Obesity Prevention Program.” **Redmond L, MS, RD**; Eckmann T, MPH; Pardilla M, MPH, MSW; Swartz J; Platero H; Gittelsohn J, PhD.

2015 American Public Health Association Annual Conference; Chicago, IL: November 3

Presentation: “Monitoring and Evaluation of a Healthy Lifestyle Promotion Program for the Prevention of Childhood Obesity Among 8-12 Year Olds Enrolled in an After-school Program in Chicago, IL.” **Redmond L, MS, RD**; Guarrine M; Hershey A; Delgado B; Fonseca-Becker F, DrPH, MPH, RD.

2015 Navajo Nation Human Research Review Board Annual Conference; Window Rock, AZ: October 22

Presentation: “A multi-institutional obesity prevention program (OPREVENT) is associated with increased time and intensity of vigorous physical activity.” **Redmond L, MS, RD**; Eckmann T, MPH; Pardilla M, MPH, MSW; Swartz J; Platero H; Gittelsohn J, PhD.

2015 American Academy of Nutrition and Dietetics Food and Nutrition Conference and Exposition; Nashville, TN: October 6

Poster: “Improving Nutritional Habits to Decrease Childhood Obesity through Development of Monitoring and Evaluation Capacity in a Community Based Organization in Chicago.” **Redmond L, MS, RD**; Guarrine M; Hershey A; Delgado B; Fonseca-Becker F, DrPH, MPH, RD.

2015 Tufts University The Future of Food and Nutrition Student Research Conference; Boston, MA: April 11

Poster: “Partnering with community organizations to improve outcomes and boost sustainability.” **Redmond L, MS, RD**; Guarrine M; Hershey A; Delgado B; Fonseca-Becker F, DrPH, MPH, RD.

2015 LEAH Annual Meeting; Washington, D.C.: January 24

Presentation: “Impact Evaluation of OPREVENT: The Obesity Research Prevention and Evaluation of Intervention Effectiveness in Native North Americans.”

2010 Alaska Dietetic Association Conference: Anchorage, AK

Presentation: “In adult critical care patients, how does the use of prebiotics and probiotics affect the overall health and rate of recovery of the patient?”

Memberships

American Public Health Association (APHA)

Academy of Nutrition and Dietetics (formerly American Dietetic Association, ADA)

- Student Council Liaison, 2009-2010

American Society of Nutrition (ASN)

National Society of Collegiate Scholars (NSCS)

Alpha Lambda Delta Honor Society (ALD)

HONORS AND AWARDS

2016	Kappa Alpha Theta Foundation Scholarship
2015	Gordis Teaching Fellowship
2014-2017	Leadership Education in Adolescent Health Fellowship (LEAH)
2014	Harry D. Kruse Fellowship in Nutrition
2014-2016	J&J Community Health Care Scholars Program
2012	Graduated James Madison University Cum Laude
2010-2012	Graduate Tuition Waiver Scholarship
2009	Graduated Clemson University Cum Laude and with General Honors
2006-2009	Dean's List
2006	President's List
2005-2009	Phillip H. Prince Alumni Presidential Scholarship
2005-2009	Out of State Tuition Collegiate Scholarship
2005-2009	Calhoun Honors College

PUBLICATIONS

Manuscripts

Coe WH, **Redmond L**, Parisi JM, Bowie J, Liu EY, Ng TY, Onyuka AMA, Cort M, Cheskin LJ. Motivators, barriers, and facilitators to weight loss and behavior change among African American adults in Baltimore City: A qualitative analysis. *J Natl Med Assoc*. In press.

Gittelsohn J, Jock B, **Redmond L**, Fleischhacker S, Eckmann T, Bleich SN, Loh H, Ogburn E, Gadhoke P, Swartz J, Pardilla M, and Caballero B. OPREVENT2: Design of a multi-institutional intervention for obesity prevention and control for American Indian adults. *BMC Public Health*. 2017;17(105):1-9.

Womack CJ, Lawton DJ, **Redmond L**, Todd MK, Hargens TA. The effects of acute garlic supplementation on the fibrinolytic and vasoreactive response to exercise. *J Int Soc Sports Nutr*. 2015;12(23):1-8.

Chapters

Redmond L, Gittelsohn J. Chronic disease among Native North Americans. In: Fleming and Manning, eds. *Rutledge Handbook of Indigenous Wellbeing*. Canberra, ACT: Rutledge; In press.

Redmond L, Kahan S. Commercial Weight Management Programs. In: Mullin, Cheskin, and Matarese, eds. *Integrative Weight Management*. New York, NY: Springer; 2014:293-301.